POWER

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Try It on the Engineer

INSTEAD of asserting himself as the responsible head of a department, the man in charge of the power plant is too often contented to let things slide as he and his associates have been accustomed to see them slide for years.

Perhaps he knows that the plant could be run at less expense and perhaps he knows how to do it, but he receives so little appreciation and interest from headquarters, especially when the proposed improvement involves a little investment, that he loses interest and becomes disheartened and discouraged.

Instead of making a real engineer of himself with an earnest effort for the best that can be done under his conditions, a pride in his record and an intelligent study of possible improvements, he is resigned to go along as a laborer under somebody else's direction, aspiring to no greater responsibility than to keep the pressure up and the "speed" going.

In a great many cases these men do not realize the savings that they could make, especially by the application of modern methods. And often even if they do realize these possibilities they are not qualified to present them convincingly to a manager or a board of directors.

Here is an opportunity for an astute salesman to do a good turn for his house, his prospect and for the engineer.

If his proposition has such inherent merit that it is bound, intelligently applied, to result in a saving, he can convince an engineer that he is an engineer and that his recommendation of it and his successful use of it will result in credit to himself with the boss.

If he can so school an engineer in the principles of the thing, its application to his conditions and its probable savings, that he can get the boss interested, he may land the job.

And if he does he has made the engineer a bigger man in the estimation of his employer and in his own opinion, and has enlisted his interest in the successful outcome of the venture in the surest possible way.

F. R. Low

EDITORIALS

When the Operating Engineer Passes His Prime

EVEN in periods of industrial activity, *Power* frequently is asked for advice by engineers who, after passing what some call the economically fatal age of forty, find themselves without employment. In spite of their acknowledged ability to handle all the operating phases of a power house, these men discover that once out of a position, another one is most difficult to secure.

When industry was made up of many small units, each managed by the owner, his feeling of loyalty toward employees kept many a grizzled engineer on the job long after his physical age prevented an active work day. Often a young man carried the brunt of the actual operation, while the old timer sat in a comfortable door seat, dozing in the sun. But the arrangement was not all one-sided, for scarcely a day passed but some one drew upon his fund of experience.

Today the small industrial plant has been swallowed up by the merger; absentee ownership is prevalent, and the management, interested in showing sufficient profit to justify its retention, has, in many instances, thrown overboard the old, shall we say fuedal, theory of loyalty to the workman. Youth, so business declares, must be served.

While the number of engineers facing this problem is small compared to the total in other activities, yet their problem is probably among those most difficult of solution. Seldom, if ever, is the operating engineer's emolument in keeping with his responsibility. So his desire to lay by for the proverbial rainy day is defeated by sheer lack of opportunity. He cannot retire when the arrival of a few gray hairs prevents re-employment in another power plant, but must turn his hand to other means of existence. Unfortunately, a long tenure as a power plant engineer, tends to narrow development along other lines, so he is unprepared to give his best service, save in plant operation. He is informed, probably exceptionally so, concerning power plants; but this is of no benefit when he turns toward other things.

Among the lowest paid of skilled operatives, yet with a greater responsibility than most mechanics who may be making twice his wage, the engineer's status is entitled to especial study. Physical activity is not as essential in the power house as elsewhere, and operating experience, an invaluable possession, can only be acquired at the expense of years.

What shall be done about it?

Oil Engine Possibilities In the Public Utility Field

CONSIDERING the cheapness of the power produced and the great improvement of design and reliability in operation of oil engines, the dullness in this branch of American industry is out of all reasonable proportion to its possibilities. True, their field is enlarging. They have practically replaced steam and gasoline engines in power shovels, excavators and numerous other forms of power for construction and field service. Oil engines are used increasingly in diesel-electric railway-locomotive service. Their position in marine service is well established and growing. But in electric power plants their market remains, just as it has for a long time, decidedly undeveloped.

This is not to say that some manufacturers may not be well satisfied with the amount of oil engine business they are doing. They are the exception, however. One particular difficulty seems to lie in the position into which the diesel engine has got with respect to one of its largest potential users, the public utility group. There is no denying that at times there has been strong opposition between power companies and municipal-ownership enthusiasts and that many municipalities have installed diesel engines with eminently satisfactory results. Consequently, to some of the public utilities, the oil engine has become the symbol of those interests they regard as stumbling blocks to their commercial welfare. To them the use of an oil engine in their system would be treason, and the mere consideration of it, sacrilege, regardless of its economic desirability.

Now, under certain circumstances the small municipally owned plant is justified. For a utility to extend its lines to pick up the load might easily cost too much

and so impose an undue burden on the rest of the consumers, although later, when the growth of load would warrant, it might well be taken into the system.

So, then, if the utility should adopt a policy of helpfulness instead of opposition it is reasonable that the municipal plant would welcome the advent of the public utility service on economic grounds and gladly turn its responsibilities over to the power company. Thus the utilities' opposition to the diesel engine will fade.

This is a practical thing and worth working for. If the diesel manufacturers will fit their policies to it, they will be opening the door to one of their largest undeveloped markets.

Neglected Coal Markets

POWER ENGINEERS have woefully neglected a major factor in dollar efficiency. They have given much study to thermal efficiency. Fixed charges, as determined by investment, have had ample consideration. But energy buying, the third factor in the power-cost trinity, has been almost forgotten. The losses total millions of dollars annually.

G. B. Gould makes this point painfully evident in his series "Coal Buying for Profit" now running in *Power*. He also proves conclusively that the money to be saved by scientific coal purchasing frequently exceeds that obtainable from any increase in thermal efficiency.

Finally, he shows, in this connection, the joint responsibility of designer and operator. Too often the plant designer loads the new or revamped plant with a perpetual liability by limiting its field of fuel selection. This liability, capitalized, may equal or exceed the entire cost of the plant.

Too often, also, the operator misses the opportunity, within existing limitations of plant and operating requirements, to shave fifty cents to one dollar per ton from the equivalent coal price (corrected for B.t.u. variations).

As far as the operator is concerned, the excuse, if any, for this situation is the complex character of the coal market. He may be honestly convinced, from his own experience, that his plant will not operate on low-priced coals. His several attempts at such operation may have been total failures. Such experiences convince him that the case is hopeless, yet they really prove nothing except that the particular coals he tried would not work.

In such experimentation the law of averages stacks the cards against the operator. It may easily happen that six out of seven high-volatile low-cost coals available are unsuitable. The seventh, a real B.t.u. bargain, will probably remain unrevealed by one or two random experiments. The operator who studies Mr. Gould's article will find paths leading out of this maze to highly attractive operating savings.

For the designer there is less excuse. It is clearly false economy to load a new plant with undersized stokers or pulverizing equipment, and otherwise perpetually limit its operation to the more expensive fuels. Subsequent B.t.u. records may ease the conscience, but they will not help the pocket book.

Mr. Gould's articles, designed to awaken the profession to this crying need and instill sound principles of coal selection, are an outstanding contribution to the present needs of the power field.

High-Temperature Steam

APPLICATION of higher steam temperatures now stands out as the next milepost to be passed in the procession of improvement to the thermal economy of power plants. Advance in this direction was long hindered by the lack of metals suited to the new conditions, but steel alloys are now available with sufficient tensile strength and low "creep" rate to make them suitable for use with steam at one thousand degrees Fahrenheit. Strength of metals is not, however, the only problem preliminary to the practical advent of high steam temperatures.

At one thousand degrees piping and fittings are red hot and will set afire any inflammable material contacting with them. Leaking steam at this temperature will ignite inflammable material in its path. Thus a considerable fire hazard is introduced.

Piping at these temperatures is subject to oxidation, not only on the outside, but quite probably on the inside as well. Tests made by C. H. Fellows have shown that at temperatures of one thousand degrees steam dissociates into hydrogen and oxygen; the oxygen combining with the steel forms black oxide of iron, thus speeding corrosion. The amount of such dissociation, while relatively small, is a factor to be considered. Provision for expansion, development of satisfactory pipe joints, and heat insulation, are additional problems to be solved.

Although solution of the main problem, that of satisfactory metals, is well advanced, there is nevertheless much pioneering yet to be done. That it will be, is to the everlasting glory of the research and experimental engineers.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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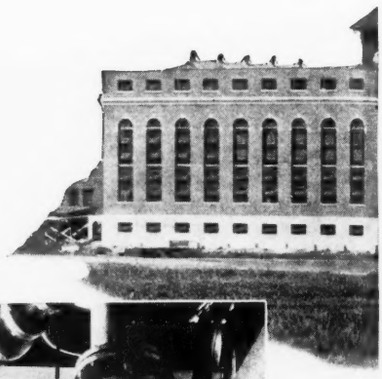
New Whittall Plant Delivers Condenser Heat to Process

Hot circulating water to dye house supplements steam bled at 20 lb. from 1,500-kw. and 300-kw. turbines. Other features include stokers, automatic combustion control, and turbine-driven auxiliaries



FOLLOWING the recent trend toward modernization of New England industrial plants, the M. J. Whittall Associates, Ltd., Worcester (Mass.) manufacturers of the famous Anglo-Persian rugs, have completed a new and strictly modern plant to furnish steam and electricity for supplying the carpet mills and all buildings in connection with the mills.

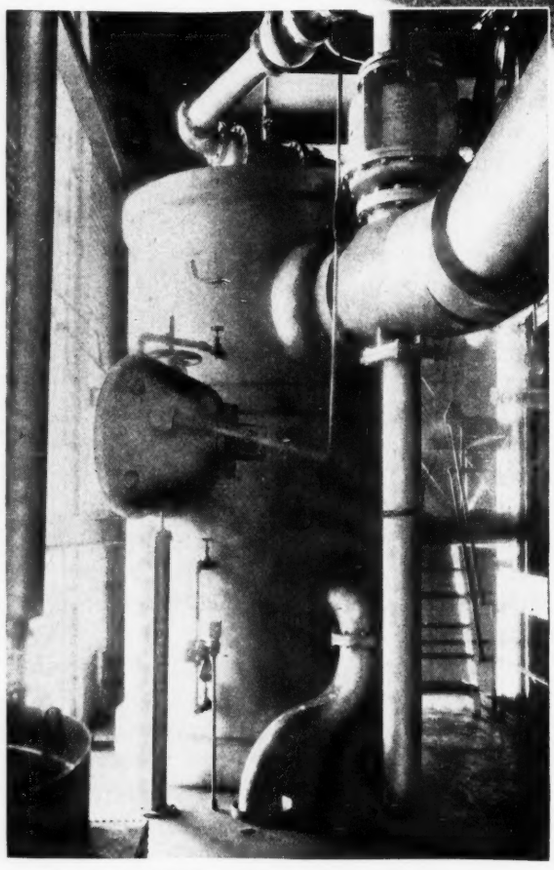
The turbines in this plant will be bled at 20-lb. pressure for process heat. In addition the hot circulating water from jet and surface condensers may be delivered as required for dye-house purposes. Stoker firing, with automatic combustion control, is installed. Turbines are used extensively for auxiliary drives. The plant was designed and constructed by Francis J. Sill, consulting engineer, of Westboro, Mass.

In the old plant a reciprocating engine drove a 40-cycle generator for power and lighting. Saturated steam direct from the boiler was reduced to 60 lb. for process and building heating.

The new plant generates 60-cycle current for power and lighting by turbine-generators and furnishes exhaust steam for process and building heating by turbine extraction for the greater part, with superheat depending on the turbine load and the steam make-up requirements. The change in current and steam characteristics necessitated repiping, installing new cables, rewiring and replacing motors; also replacing pulleys, etc., throughout the mills and buildings.

A 1,500-kw. turbine-generator in the new power plant will accommodate the present maximum electric load, and a 300-kw. unit will supply the overtime night loads, etc. A 300-kw. Worcester Electric Light Company connection for night and Sunday use, and a 75-kw. waterwheel generator, complete the power supply.

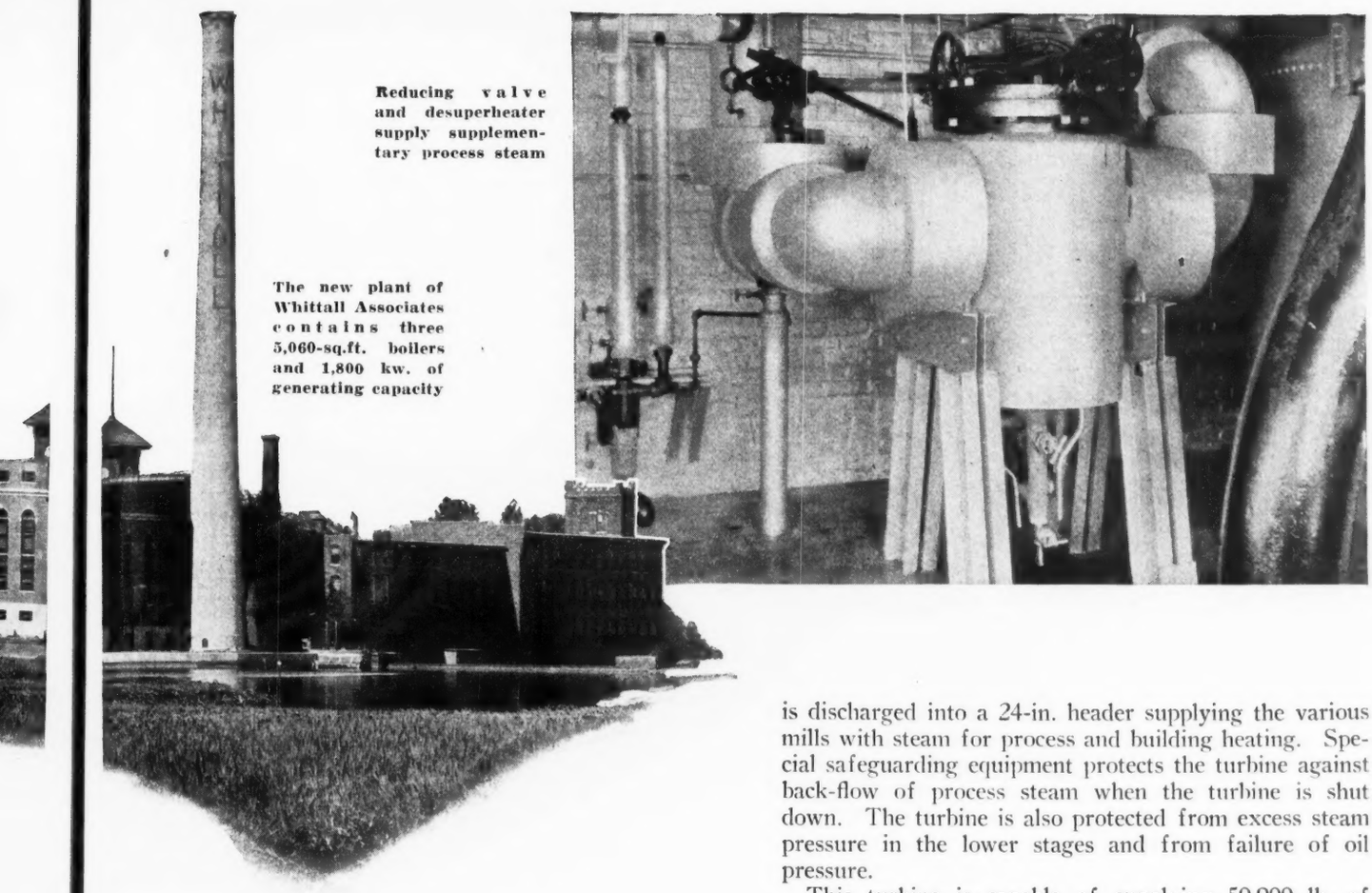
The steam load requirements equal or exceed the electric load during the greater part of mill operations, so that all steam necessary to generate electricity during mill operations can be utilized in the mills as exhaust steam. The cost of generating electricity is therefore based on the cost of turbine-generating equipment and of its operation.



The deaërating heater handles 140,000 lb. per hour

Bituminous coal is carried by tractor to a ground-level hopper. It is automatically fed to a continuous-bucket elevator delivering to an overhead belt conveyor which deposits the coal in an overhead storage bunker.

A coal gate opposite each boiler delivers to an automatic coal scale. The coal scales, one per boiler, are mounted on tracks so that they can be moved, if necessary, to supply adjacent boilers. Each coal scale dis-



Reducing valve and desuperheater supply supplementary process steam

The new plant of Whittall Associates contains three 5,060-sq.ft. boilers and 1,800 kw. of generating capacity

charges into a separate coal hopper. From each hopper the coal flows by gravity through patented coal distributors into the stoker hoppers.

Ash hoed out of the ashpit is delivered by a vacuum system to a storage tank outside of the building adjacent to the bucket elevator. This discharges to trucks.

Three 5,060-sq.ft. inclined straight-tube boilers are installed. These are designed for 200-lb. maximum pressure, and 100-deg. superheat, each unit being capable of generating 50,000 lb. of steam per hour. An integral economizer is situated at the rear of each boiler inside of the setting.

Combustion Control

The automatic combustion control installed is actuated by the main steam header pressure and furnace draft. It maintains equal rates of combustion on all boilers in service, regardless of fuel bed resistance. The system is controlled by a master panel and individual boiler panels.

Steam from the boilers is collected in a 16-in. welded manifold header supplying steam to the turbine throttle at 175-lb. gage and 100-deg. superheat. Steam flow from each boiler and to each turbine is metered. Steam-driven auxiliary equipment includes: Forced draft fans (turbine), boiler feed pumps (turbine-driven), stoker drives (turbine), auxiliary exciter (turbine), ash-handling system, surface condenser air-removal jets, jet condenser air-removal jets and auxiliary oil pump (turbine).

The 1,500-kw. turbine generator is designed for extracting steam at a constant pressure of 20 lb. gage. This is discharged into a 24-in. header supplying the various mills with steam for process and building heating. Special safeguarding equipment protects the turbine against back-flow of process steam when the turbine is shut down. The turbine is also protected from excess steam pressure in the lower stages and from failure of oil pressure.

This turbine is capable of supplying 50,900 lb. of steam per hour for extraction, at a load of 1,500 kw., based on a flow at the throttle of 53,000 lb. per hour and a vacuum of 27 in. The generator is designed for 80 per cent power factor, 600-volt, 60-cycle, 3-phase operation. It has a direct-connected exciter.

The 300-kw. turbine-generator is designed for extracting steam on the basis of a pressure-reducing valve in the extraction line beyond the turbine. The extraction line discharges into the 24-in. steam header for mill process at 20 lb. gage. This turbine, like the 1,500-kw. unit, is adequately protected by special devices. It is capable of passing 3,400 lb. of steam per hour, for extraction at a load of 300 kw. based on a flow at the throttle of 8,275 lb. per hour and a vacuum of 27 inches.

The reserve supply of process steam is obtainable direct from the boiler through a reducing valve and a desuperheater. The process header is protected by a relief valve set to relieve at 28 lb. gage.

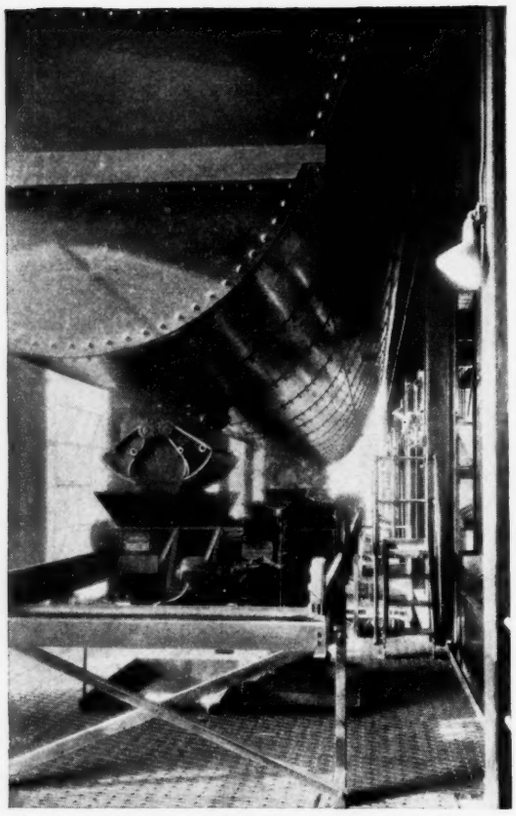
A line from the process header to the deaërator, with a pressure reducing valve (20 lb.-30 lb.) is also connected to the auxiliary exhaust header to make up the total steam required for the deaërating feed-water heater. Steam for heating the turbine room and chemical feed tanks is also supplied from the process header.

Boiler-Feed Water

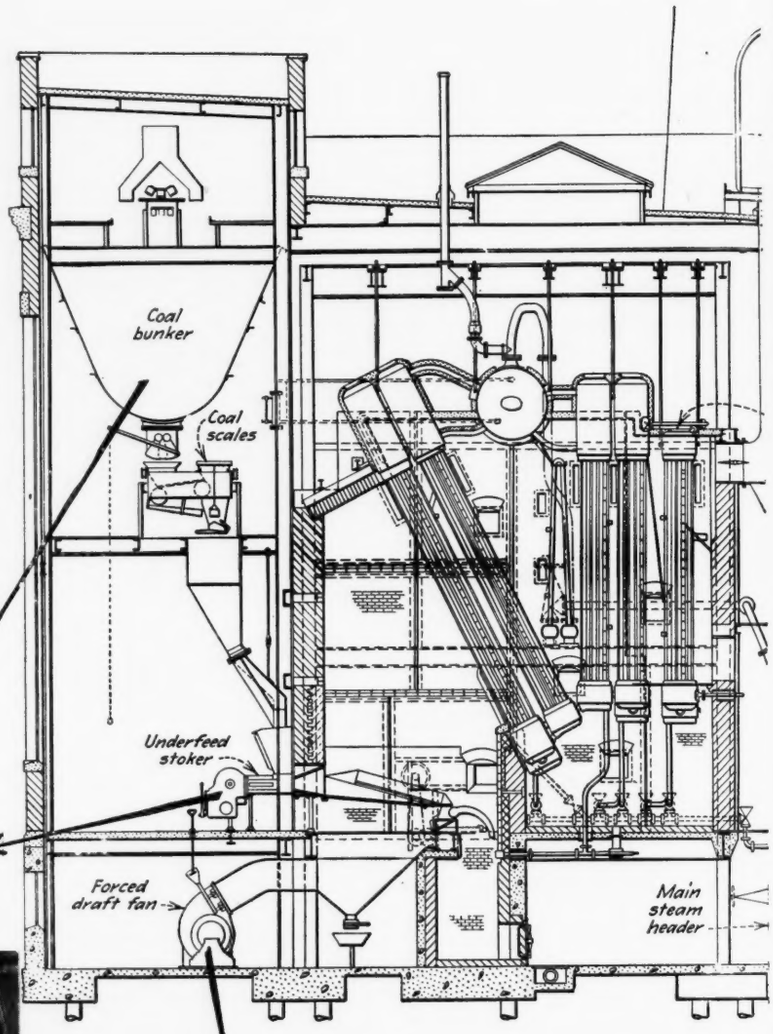
Raw make-up water from the Still water reservoir is pumped through two water filters into the first tank, after being treated with alum and alkali. The water is also treated by chemicals from a small tank on the deaërator platform, the tank discharging into the deaërator discharge pipe.

Condenser circulating water flows from the bottom of the reservoir through a 20-in. cast-iron pipe under the

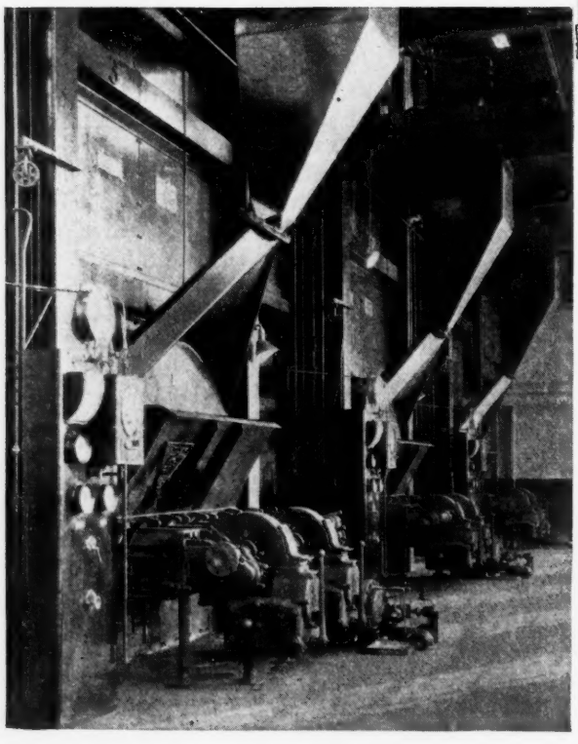
A Camera Trip Through



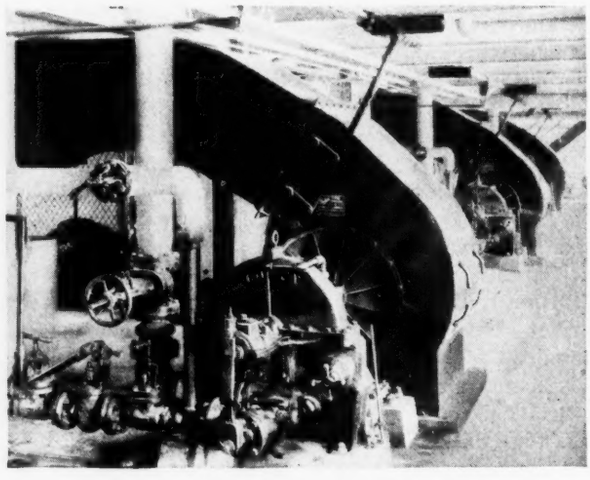
COAL BUNKERS discharge to movable coal scales, one for each boiler



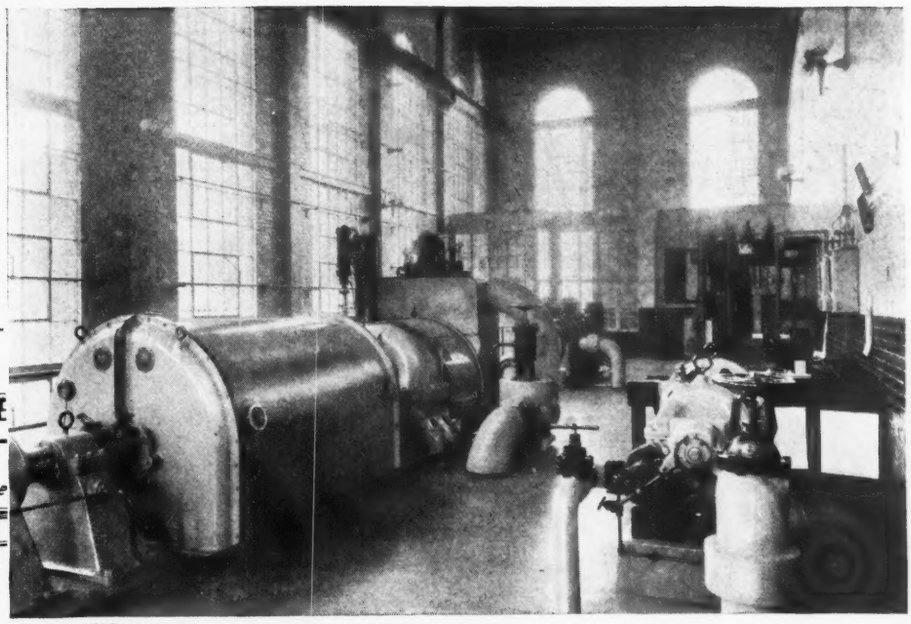
UNDERFEED STOKERS, turbine-driven, are regulated by automatic combustion control. Coal is fed through patented distributing chutes

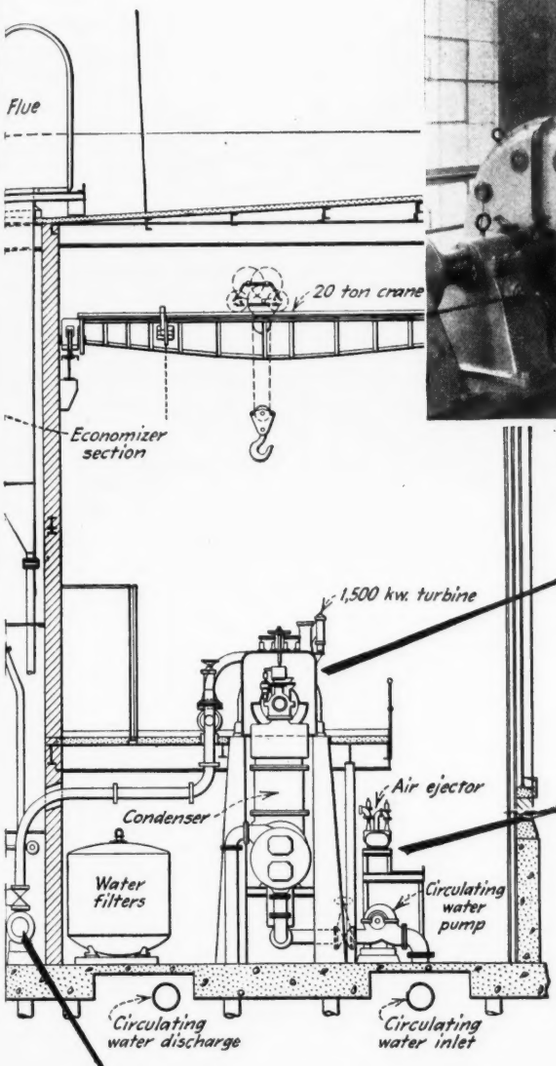


FORCED-DRAFT FANS are turbine-driven and automatically controlled



Whittall Plant

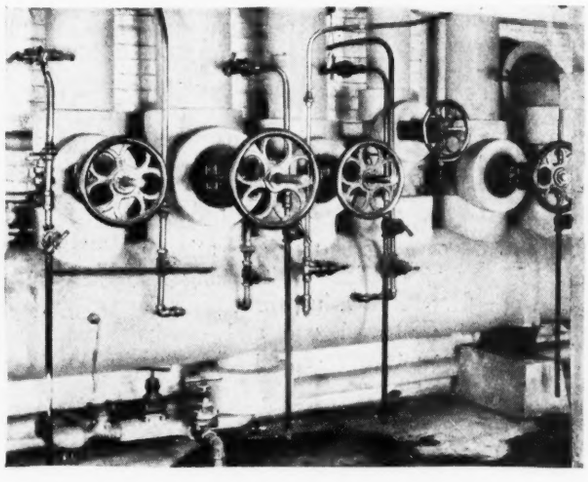




BLEEDER TURBINES supply process steam at 20 lb. In addition, condenser circulating water may be delivered to dye house. In foreground is 1,500-kw. turbine-generator, 300-kw. unit in background

CONDENSER FLOOR with jet condenser removal pump (for 300-kw. turbine) in foreground. In background are circulating pumps for surface condenser of 1,500-kw. unit

STEAM HEADER is provided with sectionalizing valves



power plant to a point under the circulating-water pump. That passed through the surface condenser of the 3,000-kw. machine can then be returned to the reservoir or delivered to the dye house. The circulating-water discharge from the jet condenser on the 300-kw. machine can similarly be thrown to waste or used in dye house.

Instruments

The customary flow meters, venturi meter, recording and indicating thermometer and pressure gages and electrical temperature alarms are installed in the power plant to record and indicate the various steam, water and air flow temperatures and pressures.

This article is based on information supplied by the consulting engineer, Francis D. Sill.

Municipal Light Plant Sells Current to Public Utility

By BENNETT B. SMITH

A NOTED newspaper man once remarked that there was no element of news in a dog biting a man, whereas the story of a man biting a dog would justify an extra edition. So many municipalities purchase power from public utilities that the story has grown trite. Baldwin City, Kan., reverses the rôles, sells excess current to a transmission line and so claims its share of fame.

Prior to 1906, a small plant supplied lights to a local college. This was taken over and the proceeds of a $10,000 bond issue invested in a natural-gas engine and direct-current generator and the necessary pole lines. The local supply of gas gradually decreased until in 1917 this fuel was abandoned and a 165-hp. four-stroke-cycle Diesel and generator were installed, using the proceeds of a $20,000 bond issue.

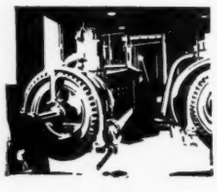
The system was changed from direct to alternating current and the lines were rebuilt. The engine was run continuously for 7 years, 24 hr. per day, 7 days per week, except for a few hours on Sunday afternoon, when it was shut down for cleaning and repairs.

But the load was increasing and the unit was being operated too strenuously. Motors had been installed at various places and electrical energy was needed for the water-system pump.

In 1924 another 180-hp. diesel unit was installed, along with a new switchboard and other improvements, at a cost of $20,000, all of which was paid for with profits of the plant, a bond issue being unnecessary.

The original unit, which has been in service for thirteen years, is in as good condition and operates as smoothly as it did when first installed. Its only major repair has been the replacing of a cracked cylinder head.

Since 1924 repairs at the plant and on the lines have been more or less neglected, with the result that last year a large amount, considering the plant's size, was expended for much-needed work. This amounted to $2,733.11, compared with only $56.35 in 1929, the latter being an approximate average of previous years. This was the largest item of expense in the plant's operation in comparison with 1929, other expenses being somewhat reduced.



High lines have made great inroads through this section and have taken over many of the small-town plants which were not operating profitably. But Baldwin City has entered into a 20-year contract to furnish current in its vicinity for a public utility whose main office is in Kansas City, Mo. The charge is four cents per kilowatt at the board, and the company builds and maintains its own lines. Lines extend in all directions, taking in several small towns and a number of farm homes. The situation now facing the local plant is that of being in competition with itself. A few farmers had installed service from the Baldwin City plant before the coming of the high line, and now it is reported the utility offers to sell current to those farmers cheaper than they are now buying it from the city.

Not only did this plant pay for the installation of the new generating unit in 1924, but a number of other repairs and additions to the lighting system have been made and paid for out of earnings. At the time of the installing of the new unit in 1924 and the rebuilding of lines, all unsightly poles were removed from the business section of the town and new ornamental white-way poles were erected. At the same time a new cooling system for the engines, of the closed type, was put in. Previously, water flowed through the units and into the sewer, resulting in a great loss of water. The town's streets are lighted all night without a tax assessment.

OPERATING COSTS—BALDWIN CITY MUNICIPAL PLANT

	1929	1930
Total kw.-hr. generated	527,145	539,500
Total kw. capacity	230	230
Peak load, kw	192	150
Load factor—per cent	26.1	26.7
Unit cost of oil per kw.-hr., cents	0.48	0.36
Kilowatt-hour per gallon fuel oil	9.35	9.60
Fuel oil used, gal	56,230	59,557
Plant Operating Cost:		
Fuel	$2,541.32	$2,482.01
Lubricating oil	677.80	882.61
Repairs	56.35	2,733.11
Attendance	5,710.00	5,120.00
Operating total	$8,958.47	$10,217.73
Cost per kw.-hr. at switchboard	$0.017	$0.019
Overhead:		
*Interest	$1,000.00	$1,000.00
Depreciation, 5 per cent	5,000.00	5,000.00
Insurance	209.30	147.60
Overhead total	$6,209.30	$6,147.30
Operating total	8,985.47	10,217.73
Grand total	$15,194.77	$16,365.03
Total cost per kw.-hr	$0.0289	$0.0303
Total power and light income	$21,602.94	$21,942.88
Income per kw.-hr	0.0401	0.0408

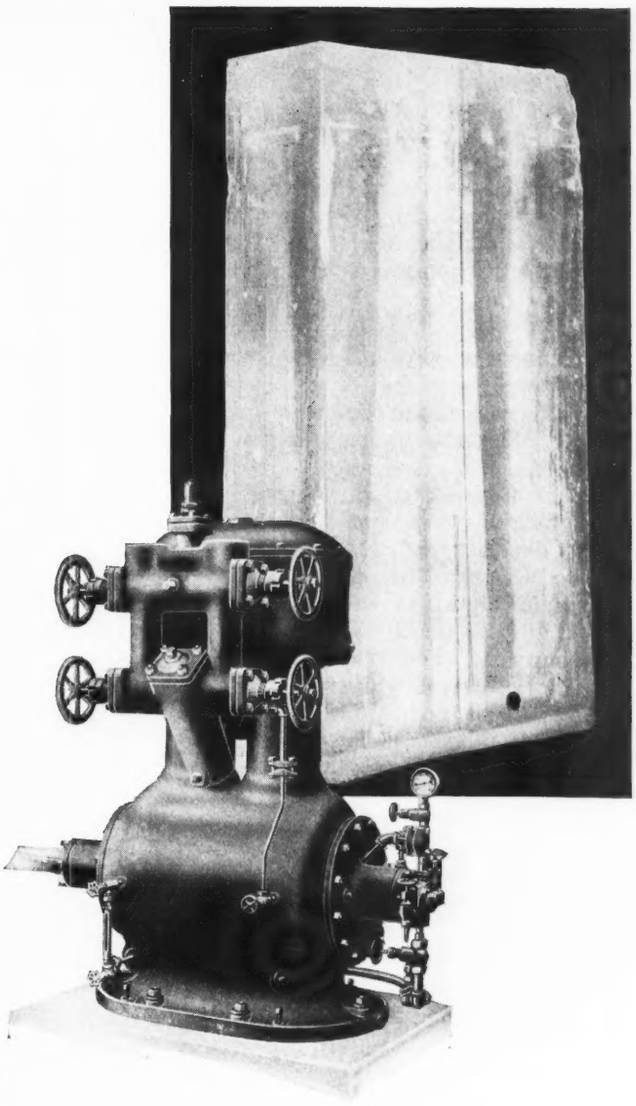
* This is taken as 1 per cent on $100,000, but since the plant has been paid for out of earnings it is questionable if interest should be charged at all.

A flat rate of nine cents per kilowatt is charged consumers for lighting. Other towns in the vicinity are using a sliding scale, but, in comparison, the Baldwin rate is cheaper, since the average consumer does not use enough current to benefit from such a scale.

For power, cooking and refrigeration a sliding scale is given, four cents being charged for the first 250 kw.-hr., three cents for amounts up to 750 and one and one-half cents for amounts over 1,000 kilowatt-hours.

Does Your Compressor Fit the Ice Production?

By M. F. KNOY



IN DESIGNING an ice plant one of the chief problems to be decided is the correct proportioning of compressor capacity and freezing tank area. Upon the proper solution of this problem will depend not only the first cost of the plant, but its operating economy and the ease with which its output may be increased in the future.

In existing ice plants compressor displacement and tank area may be found in all imaginable proportions. Upon first thought one might conclude that some definite relation between these factors should be established on sound engineering principles once and for all so that all future plants might be laid out accordingly. This at least sounds reasonable, and is in keeping with the natural tendency of engineers to evolve a single formula for the solution of any and all problems of the same type. However, the problem is not merely to decide which layout will give the lowest power consumption, nor which will give the lowest first cost, nor which will give the greatest assurance against an ice shortage in midseason. The engineer must rather make somewhat of a compromise and select the layout that will give fair assurance as to capacity and the lowest production cost per ton of ice when fixed charges on the investment are set off against power costs.

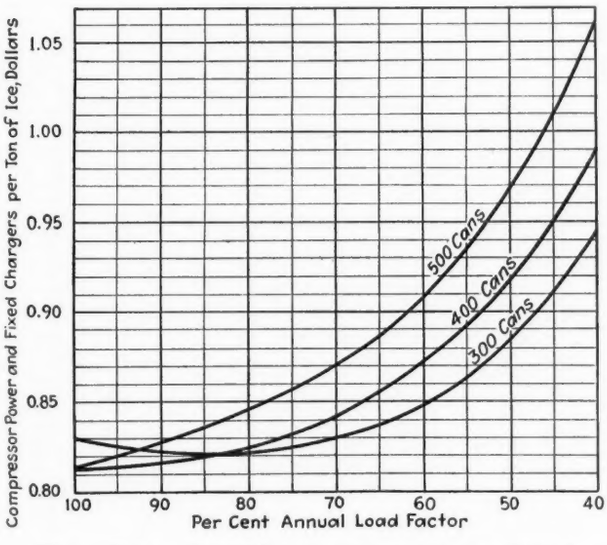


Fig. 1—Total costs based on investments given in Table I

But when we begin to analyze the various factors that enter into plant design we find them so variable that the same combination is seldom encountered in different plants. The chief of these are: load factor, nature of water to be frozen, power costs and the relative costs of compressor capacity and tank area. So closely are these factors related that no complete discussion of any one of them is possible without some reference to the others.

For my own use in the solution of problems of this nature I have worked out the chart shown in Fig. 2. This chart is based upon the actual performance of mod-

ern equipment working under normal conditions in the Central South. The curves will not be strictly accurate for all conditions, but with proper allowances should serve as a basis for estimates of plant performance anywhere. On this chart "compressor displacement" is read on the broken lines, "tons of ice produced per day" is read on the heavy curves that run in the same general direction, "number of 300 lb. cans required" is read on the vertical scale at the left and "tank temperature" is read on the horizontal scale at the bottom.

Tank Area and Compressor Displacement

In connection with load factor and maximum load, it can be readily seen that the plant must be at least large enough to meet the maximum sustained ice demand, assuming, of course, that no seasonal storage is to be provided.

Let us assume that water conditions are such that a good grade of ice can be produced with a tank temperature as low as 10 deg. F., and that the maximum output required will be 30 tons per day. Referring to the chart, Fig. 2, follow the 10-deg. line upward to where it intersects the 30-ton curve. Note that this point falls upon the 300-deg. can line and upon the displacement curve representing 400,000 cu.in. per minute. From this it will be seen that a compressor of this cylinder displacement working on a 300-can tank will hold it at a temperature of 10 deg. and produce 30 tons of ice per day. Following the 30-ton line farther to the right, we see that it crosses the 400-can line at about 15.6 deg. and calls for a compressor displacement of about 300,000 cu.in. per minute. A compressor of this size working on a 400-can tank will hold it at a temperature of about 15.6 deg. and produce 30 tons of ice per day. By following the 30-ton curve still farther to the right, it is seen that for 500 cans and 30 tons per day a compressor displacement of only about 260,000 cu.in. per minute would be required and the tank temperature would average 19 degrees.

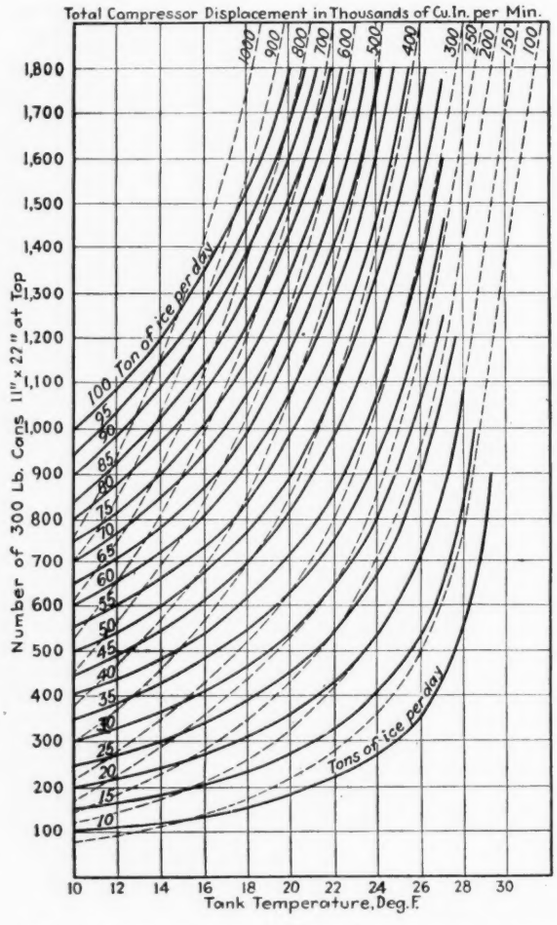


Fig. 2—Relations of tank temperatures, number of cans and compressor displacement

It is evident that the number of cans required to produce a given quantity of ice will depend to a certain extent upon the compressor capacity to be used, and that the ice production from a given compressor capacity will depend upon the number of cans in the freezing tank. Likewise, the compressor capacity may be reduced and the output kept constant if the number of cans is increased sufficiently; or the tank area may be reduced and still give the same output provided a sufficient increase in compressor capacity is made. Of course, as the number of cans is increased more tank area and building space will also be required.

Likewise, as the size of the compressor is varied, the amount of evaporator surface, condenser surface and cooling water must be varied if working pressures are to remain comparable, which is assumed to be the case. Hence when the cost of compressor capacity is given as being so much per 1,000 cu.in. per minute displacement the cost of these other items is included.

For example, assume that tank area costs $30 per can and that compressor capacity costs $9 per 1,000 cu.in. displacement. The combined cost of compressor and tank area will vary as the two factors are proportioned differently, as in Table I.

For the sake of comparison, assume an extreme condition where the cost of tank area remains the same as in the above case, but where the cost of compressor capacity is exactly doubled. The combined cost of these two items is shown in Table II.

In both of these instances the plant with fewest cans is lowest in first cost, the difference being more pronounced under the first conditions. However, when the engineer comes to consider operating costs just the reverse is true. As was noted, the 300-can tank will operate at 10 deg., the 400-can tank at 15.6 deg. and the 500-can tank at 19 deg., each producing 30 tons of ice per day. And it is a well-known fact that as the tank temperature is increased, the suction pressure on the compressor will go up and the power consumption will lower. It is thus seen that power costs will depend to some extent upon the tank area.

Power costs will also be affected by the yearly load factor, or, in other words, the average output from the tank. Fig. 2 shows that a 300-can tank at 10 deg. will produce 30 tons of ice per day. Following the 300-can line to the right till it crosses the 15-ton line, it will be seen that the same tank operating at this rate, which is 50 per cent load factor, will have a temperature of 21 deg. This high tank temperature will mean greatly reduced power consumption by the compressor. On the other hand, as the load factor falls, the total ice produced per year becomes smaller, and since the fixed charges remain constant regardless of output, the fixed charges per ton of ice will be correspondingly higher. Thus a low load factor reduces power costs but increases other costs.

Just how the proper balancing of tank area and compressor capacity is determined for various load factors is brought out in Fig. 1. Fixed charges on these two

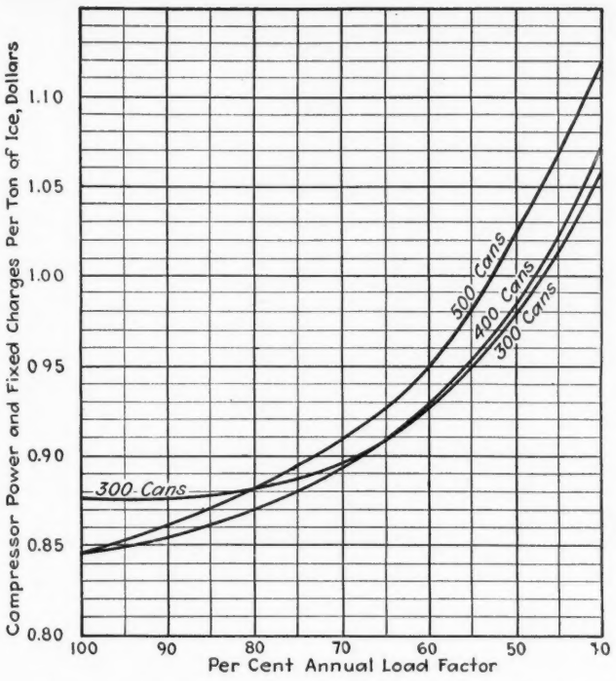


Fig. 3—Using the capital costs of Table II the above chart shows total production costs

items are placed at 14 per cent per year on the costs shown in Table I. A similar graph, shown in Fig. 3, is based on the costs shown in Table II. In each case power consumption was calculated from the theoretical horsepower per ton of refrigeration at the various tank temperatures, assuming a temperature split of 7 deg. in the evaporator, a condensing temperature of 85 deg., an over-all efficiency of motor and compressor of 75 per cent, and an energy cost of $0.016 per kilowatt-hour. Of course, all assumptions on which these graphs are based must be changed to actual costs in figuring any particular installation. It must be remembered also that the costs shown do not represent the full production cost,

TABLE I—OUTPUT AND COSTS

No. Cans	Tank Cost	Compressor Displacement, Cu.In. per Min.	Compressor Cost	Combined Cost
300	$9,000	400,000	$3,600	$12,600
400	12,000	300,000	2,700	14,700
500	15,000	260,000	2,340	17,340

but only include the cost of compressor power and the fixed charges on the items shown in Tables I and II.

From Fig. 1 it will be found that for all load factors below 84 per cent the 300-can tank will be the most economical, while for all load factors above 300 the 400-can tank has the advantage. For very high load factors it is evident that the 500-can tank compares favorably with either of the others, and is actually somewhat more economical than the 300-can tank. In the graph, Fig. 3, where all the factors except the first cost of compressor capacity remain the same, it will be seen that the 400-can tank is never very far behind the 300-can tank in economy and is even better for all load factors above 63 per cent. Even the 500-can tank is better than the 300-can tank at all load factors above 80 per cent.

The graphs bring out the fact that for very poor load factors the tank with fewer cans and greater compressor capacity will be the most economical, and that if the load factor is very high the additional investment in greater tank area will be well justified. In the same manner it could be shown that, other things being equal, higher power costs will make larger tank area still more desirable, while lower power costs will rule in favor of the smaller tank. It will thus be seen that the problem will be a complicated one in any case and will merit careful consideration.

Frequently, when designing an ice plant, some other factor prevents a selection strictly on the above bases. For example, the water may be of a nature that trouble from checking and cracking may be experienced at any temperature below 16 deg. Regardless of other considerations the plant should be designed to produce the required output at a minimum temperature of 16 deg. A case may arise in which the engineer prefers to maintain excess capacity and operate at a low load factor as a means of impressing prospective competitors. In that event it would be best to install excess tank area and evaporator surface at first and let reduced power consumption offset,

TABLE II—EFFECT OF DOUBLING COMPRESSOR COST

No. Cans	Tank Cost	Compressor Displacement, Cu.In. per Min.	Compressor Cost	Total Cost
300	$9,000	400,000	$7,200	$16,200
400	12,000	300,000	5,400	17,400
500	15,000	260,000	4,680	19,680

in part at least, the high fixed charges. Then when it becomes desirable to increase plant capacity, it is a simple matter to install an additional compressor without seriously interfering with operation. For example, suppose that a plant had a 500-can tank operating with a 260,000-cu.in. compressor and producing 30 tons per day. If it was later desired to get 40 tons per day from this tank, it would only be necessary to increase the compressor capacity to 400,000 cu.in. per minute displacement, as will be seen on the chart by noting where the 500-can line crosses the 40-ton curve. This change would be a simple matter and would cost comparatively little.

The Oversized Compressor on the Undersized Tank

Perhaps the most lamentable plant layout is one in which an oversized compressor is working on a small tank with insufficient evaporator surface and an equal lack of condenser surface. In such a case the suction pressure will be unduly low due to the great temperature split in the evaporator, and the head pressure will be unduly high due to an equally great temperature split in the condenser. Power costs will therefore be excessive because of the poor design of the plant. Though burdened with the extra cost of the large compressor, the owner is yet without any advantage in the latter of increasing the output of the plant later on. Any attempt to force the existing plant will result in increased power consumption for the reasons mentioned, and tank temperatures may go so low that a poor quality of ice will be produced. Any great increase in plant output will therefore necessitate an addition to building space and tank area, which will not only prove costly, but which may require a complete shutdown of several weeks' duration. It will thus be seen that, other things being equal, excess tank area is more desirable than excess compressor capacity.

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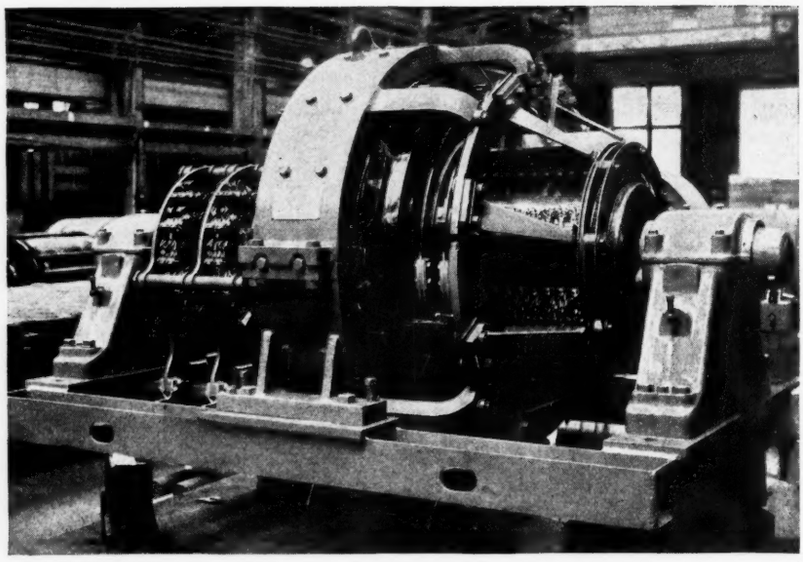
Steam and hot-water heating rates of the principal cities of the country for the heating season of 1930-31 are tabulated in a convenient and useful form in the "Annual Heating Rates Bulletin," just issued by the Ric-Wil Company, Union Trust Building, Cleveland, Ohio. On request, copies will be sent by the company to those interested.



Rotary converter equipped with double brush-holders on the commutator

Double Brush-Holders Improve D.-C. Machine Operation

By A. M. HARRISON

Power Engineering Department, Westinghouse Electric & Manufacturing Co.

Under certain conditions the use of double brush-holders on direct-current machines is advantageous; while on other machines they may be objectionable, as the author suggests in this article

DOUBLE brush-holders were tried as early as 1905, but their use was discontinued soon after because it was felt that they did not offer much improvement over the single holder. This was before commutating poles were used extensively and the commutator speeds were far below those where double brush-holders are advantageous. It was not until about 1925 that double brush-holders were tried again. At that time it was decided that they had advantages when used on high-speed commutator machines; but a double brush-holder had to be developed that was practical from an operating standpoint. A brush-holder of this type is now available in which the two brushes operate independently by using two separate tension springs; the same size brush is used in each compartment, allowing equal wear on each brush; it is possible to replace any brush without disturbing the adjacent brushes; the design is compact, so that the span over the commutator face is small.

One advantage of this type of double brush-holder is the ability of the brushes to maintain contact with the commutator. It has been proved experimentally that on a high-speed commutator (6,500 ft. per minute) a difference in height between adjacent bars of a small fraction of a mil is sufficient to produce 15 volts drop across the brush contact surface. This shows that the brush at times is leaving the surface of the commutator, due to the impact received from the slightly high bar. With double brush-holders, the two brushes do not receive the impact at the same time. Consequently, contact is practically always maintained with the commutator. Although either of the brushes may at some time leave the commutator, one of them is always making contact.

A brush on a commutator may be likened to a switch in an electrical circuit. If the switch is opened, an arc will follow, and destructive sparking is the result. If, however, two switches in parallel, instead of one, are used, either of the switches may be opened separately without interrupting the circuit, and no sparking will take place.

It is a mechanical advantage in commutator construction to have the axial length of their bars as short as

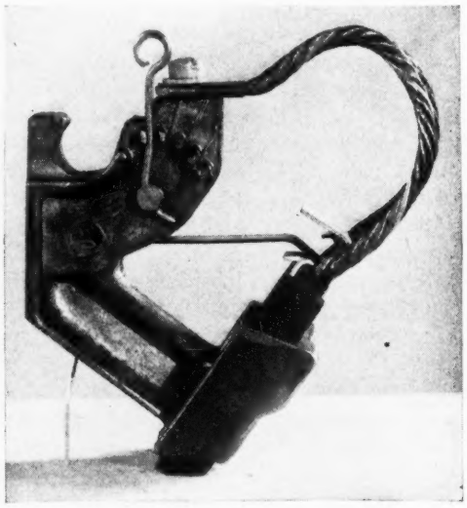


Fig. 1—A conventional type of single brush-holder

possible. Both the stresses in the bars and the bar deflections decrease rapidly as the axial length of the bars is reduced. For a given rating, the brush contact area is practically fixed; therefore to decrease the commutator's length the brushes' thickness must be increased. The foregoing suggests using the widest brush possible without exceeding a commutating zone dictated by good design. Without double brush-holders, it is not practicable to do this on high-speed commutators, because brushes more than $\frac{3}{4}$ in. thick perform poorly on this class of machines. This is due to the difficulty in making good contact on the commutator and to the inability of a thick brush, because of its inertia, to follow commutator irregularities.

Maintaining good contact under working conditions becomes increasingly difficult as the brush thickness increases, because of peculiarities of brush contact phenomena. A brush 1 in. thick will not perform as well as a brush $\frac{1}{2}$ in. thick when worked at the same density. This is probably because, regardless of thickness, a brush actually makes contact at only a very few points, and doubling the thickness of a brush does not double the number of points of contact. By using two independent

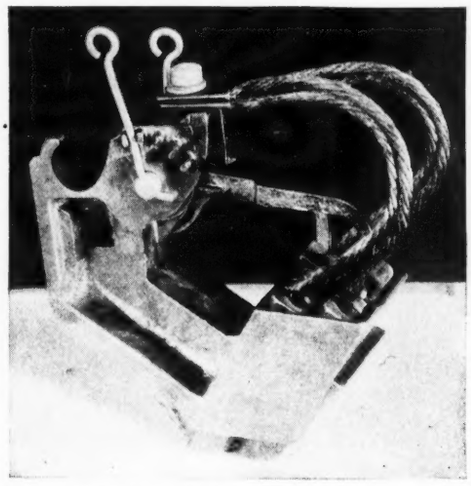


Fig. 2—Double brush-holder allows replacing a single brush by two of one half the thickness

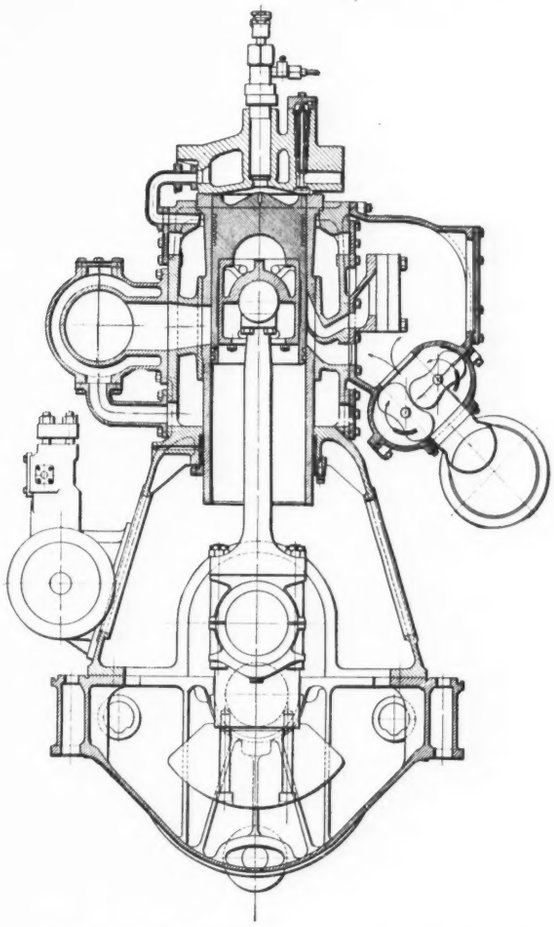
brushes, as in the double brush-holder, the actual contact area will be double that of one of them, and the inertia of the brushes is low compared to a brush of double the thickness. For these reasons the double brush-holder allows the designer to use brushes the thickness of which is dictated only by commutating-zone considerations. This thickness is considerably in excess of the limit determined by considerations of brush contact and brush inertia as imposed when a single brush is used, and enables the designer to reduce the length of commutator required for a given rating and secure good performance.

The commutating zone is that portion of the periphery through which an armature conductor passes during commutation or current reversal. It is midway between the main pole tips, and should be small enough so that the armature coil under commutation will not have a voltage induced in it due to the fringing flux from the main pole. The commutating zone is directly proportional to the width of the brush, so that if the brushes are too wide the commutating zone will extend under the main pole tips. Proper reversal of the current in the coil undergoing commutation will be hindered by the flux from the pole tips, and poor commutation will result. This explains why double brush-holders cannot be used on machines of old design. Machines of newer design have a slightly smaller ratio of pole arc to pole pitch, to accommodate the larger commutating zone which results when double brush-holders are used. In some cases it is possible to machine off the pole tips of old machines so that double brush-holders can be used.

Double brush-holders make for better mechanical construction of the commutator by enabling it to be shortened, and in addition they smooth out slight irregularities and roughnesses by virtue of the improved contact afforded by two independent brushes.

Experimental Diesel With Self-Contained Blower

AT THE TIME the Busch-Sulzer Brothers Diesel Engine Company obtained a license to use the Hesselman system of airless injection of fuel, a 11x16-in., two-cylinder, two-stroke-cycle unit, shown in the illustration, was built to test out the system. The unit is rated 200 hp. at 500 r.p.m. and its scavenging air is delivered by a self-contained, cycloidal-impeller scavenging blower, chain-driven from the crankshaft. Attention is called to the unusually thick piston crown designed to transmit the heat to the jacket with a minimum temperature gradient.



Experimental two-stroke-cycle Hesselman diesel

BUYING COAL FOR PROFIT—II

Coal Value versus Efficiency

Often intelligent coal buying will save more than any possible increase in efficiency. Get both if you can, but don't overlook coal-market profits waiting to be picked. Mr. Gould here shows the practical application of the fundamentals presented in the April 7 article

By G. B. GOULD
President
Fuel Engineering Company, New York

"EFFICIENCY," as the term is applied to a boiler plant, represents a definite and valuable engineering measurement, but is not, standing alone, a reliable index of economic success. The efficiency of a steam plant could be used with finality only if steam were produced on an "art-for-art's-sake" basis, but the truth is that most steam plants are part of some business, and one important objective of any business is to keep costs as low as possible.

And the minute costs are mentioned, the true objective in steam generation becomes a blend of engineering measurements and commercial values. Energy is bought in one form in the coal market, and converted into another form in the plant. It is the success of the combined process of buying and converting the energy that counts from a business standpoint. What is obviously needed is some kind of a scale against which the *economic* performance of a given steam plant can be measured, and compared with the lowest cost reasonably attainable under its own existing physical limitations, or with those limitations modified, or with an entirely new and completely modernized plant performing the same service.

If one could construct such a scale which would apply to *all* steam plants an astonishing amount of existing undiscovered opportunities for further economy in steam generation would be revealed, simply because the absence of such a scale is the principal factor in concealing these opportunities from the very executives and engineers who are eager to take advantage of them. It would create a considerably greater demand for modernized steam plants because it would clarify for many industrial executives the economic disadvantage of the truly obsolete plant. And it would, incidentally, defer the modernization of some plants, because it would reveal the fact that a considerable part of the anticipated saving attributed entirely to modernization is in fact represented by an undiscovered opportunity for more economical operation of the plant to be replaced.

Such a scale is clearly impossible for universal application, because steam plants are so widely scattered, draw from widely different coal-producing areas, and differ among themselves with respect to the service they perform. It is likewise impossible because the values in the coal market change with the passage of time.

Integrating Market and Plant Possibilities

Although there are obvious difficulties in the way, it is possible to create such a scale, within the limits of practical commercial usage, for a given plant at a given time. But it requires something more than a determination of the efficiency of the plant. In fact it can not be done at all with any amount of engineering investigation wholly within the plant, for the facts revealed by such an investigation *must be related* to what is probably the most intricate and puzzling market that exists for any equally important raw material. Not only are the controlling facts about the coal market difficult to get at, they are unstable. They cover a wide range of values (in terms of energy), and the individual characteristics of the plant determine the practically obtainable limit of value.

In our own case, in order to relate real coal-market values to plant performance, it was necessary years ago

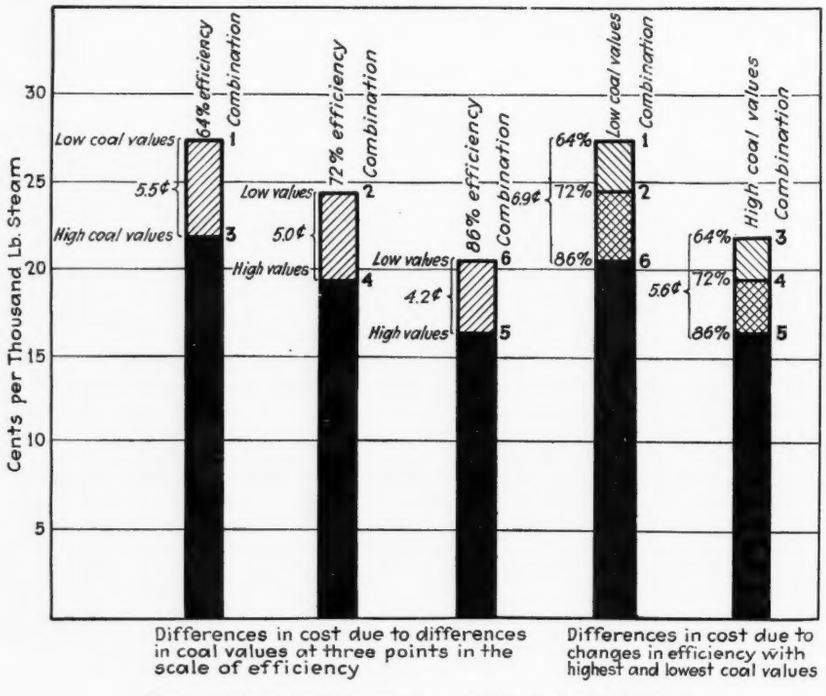


Fig. 1—Illustrating the effect on steam cost of changing coal values and efficiencies

to set up a method of operation which not only included our own coal testing laboratory, but provided a steady flow of identified samples of actual deliveries of many different coals to widely scattered plants of known characteristics. The accumulated total number of such samples tested to date is well over 100,000, with a resulting classified record of average quality for each of 3,000 different mines.

The influence of coal-market values on steam costs can be illustrated by setting up a scale such as we have been discussing on a hypothetical basis, using, however, actual coal values, and by comparing with it a few actual cases, with the figures corrected for time and location to make them comparable.

Range of Coal Market Values

In the preceding article of this series (*Power,* April 7) the range of values obtainable in the large and important group of bituminous coals which supply the Middle Atlantic States was illustrated and analyzed by using a representative sample of the district composed of definite offers of 76 identified coals, during a short period in the summer of 1930. The quality of each coal was

HOW OTHER FACTORS VARY WITH "ENERGY VALUE"

	BTU for lc.	Volatile	Sulphur	Ash	B.t.u.	FTA *	Grinding Index	Cost per Million B.t.u.	Range in Value Per Ton	Number of Coals
A	71,200	32.9	2.0	9.8	13,850	2,298	53—70	14.0c.	0–20c.	12
B	67,600	28.9	1.9	9.6	13,845	2,400	51—69	14.8c.	20–40c.	24
C	64,400	23.9	1.6	8.3	14,305	2,420	54—74	15.6c.	40–60c.	17
D	62,200	21.2	1.4	8.2	14,305	2,597	61—81	16.1c.	60–80c.	15
E	57,100	19.8	1.2	7.9	14,450	2,670	.....	17.5c.	80c.+	8
										76

*Fusion temperature of ash, deg. F.

(In order to eliminate the effect of size on the value scale, the offers were limited to run of mine in the low-volatile coals, and to slack in the high-volatile coals. Slack coals are infrequently produced in the low-volatile fields, and the inclusion of the screen sizes in the high-volatile coals would only complicate the results by a variable, the effect of which is obvious.)

fixed by an average of tests we made on samples of actual deliveries of each of these coals. With this data it was possible to arrange all of these offers in the order of the amount of energy being offered for one cent, and to compare the changes in physical characteristics as the price of energy went up.

The average value of the 12 coals which represented the lowest price for energy indicated that one cent would buy 71,200 B.t.u., while the average yield of the 8 coals at the other end of the scale was 57,000 at a point taking a freight rate of $2.76 per net ton. Or, putting it another way, the cost of one million B.t.u. was 14c. for one group, and 17½c. for the average of the other group or 25 per cent higher. The two individual coals at the two extremes of the scale represent a range in cost of energy from 13.6c. to 18.6c., or a difference of 37 per cent. While it is true that individual plants are buying their energy at these two extremes, and possibly beyond them, the hypothetical scale of steam costs has been set up on the more conservative basis of using the *average* of the *group* of coals at each end of the scale of market values.

In combination with these market values, it is necessary to assume certain efficiencies, and to figure evaporation on a "from and at 212 deg." basis allowing for an average moisture of 3 per cent. The actual cost per thousand pounds of steam, under most operating conditions, would be possibly a cent higher.

To avoid repetition, let it be understood that "efficiency," as here used, represents the combined efficiency of furnace and boiler, as well as economizer or air-preheater, or, in other words, the whole steam-generating process, whatever it happens to be. Nor is efficiency used in the sense of "test" efficiency, but the average performance of a plant during periods of normal operating load, that is, excluding banked periods, which will vary in length among plants from a few hours a week to more than half of the elapsed time.

Now a plant which (from necessity or choice) is using a coal at the low-value end of the scale, and is operating at 64 per cent efficiency, will have a coal cost of 27.3c. per thousand pounds of steam (point 1, Fig. 1). This efficiency may seem like a low starting point for this comparison, but the truth is there are still many plants doing no better than that.

Efficiency vs. Cheap Fuel

Assume for the moment that this plant is actually limited to that group of coals which yield so little energy for a dollar, what difference will it make to steam costs if the efficiency is raised to 72 per cent? The coal cost will then be 24.3c. (point 2) or about 11 per cent lower.

This, of course, is elementary; but it becomes more interesting, when the other factor of coal-market values is considered. If this same plant, instead of being limited in its coal buying, could avail itself of the best values obtainable, its cost would be reduced to 21.8c. (indicated at 3), a 20 per cent reduction without improving its efficiency at all. In other words, the actual range of coal-market values can affect the coal cost per thousand pounds of steam nearly twice as much as the rather considerable spread in efficiency from 64 per cent to 72 per cent.

For the convenience of those who like to translate unit costs into the approximate totals that might apply to them personally, a difference of one cent in the cost per thousand pounds of steam is roughly equivalent to $1,000 for every 5,000 tons of coal burned.

Therefore, if, in this imaginary plant, one could choose between higher efficiency with the same low coal values and the low efficiency with the better coal values, the latter alternative would reduce costs more than $5,000 for every 5,000 tons formerly burned, while the former would reduce them only $3,000. The one, measured by the accepted engineering standard of efficiency only, might be considered a creditable engineering achievement, but viewed in the light of sufficient data on coal market values could only be classed as a neglected economic opportunity.

In an actual plant, of course, there is always the additional possibility of a compromise that would yield a still lower cost. That is where a careful analysis of both the plant and the coal market is particularly useful.

But, to proceed further down the scale of costs, if this plant were able to improve efficiency to 72 per cent and at the same time avail itself of the better coal values, the cost would drop to 19.3c., indicated at 4 in the scale. Now a peculiar thing has happened, for the coal cost of this very ordinary plant, such as might have been built any time in the last fifteen or twenty years, operating at an efficiency which can be classed as good but not phenominal, is found to be lower than the cost in the most modernly equipped plant operating at the high point of 86 per cent efficiency, if that plant is limited, as some are, to coals which yield the low values.

By using the coals which yield the better values, on the other hand, this very modern plant will have a coal cost of 16.2c., 25 per cent below the point 3 and some 40 per cent below the starting point 1. It is obviously important to known where a plant's performance stands in the scale of coal values, as well as efficiency.

In an actual plant, of course, the problem is not as

simple as this. Analysis would reveal whether efficiency was depressed by incorrect coal selection, by plant design or by defects in operating methods and how much each one weighed in the combined result. It would show whether the coal-market values being obtained were limited by actual plant conditions, or by a faulty diagnosis of those conditions, or by inadequate information on coal market values. And from this it would be possible to establish just how far down this scale of costs the particular plant could go before reaching its practical limit of coal values and efficiency, and just what it would be necessary to do to get there.

It can be seen from this that such a scale is important in establishing the actual economic value of a proposed modernization project. If in fact a plant is limited to low coal values and to low efficiency, then a modernization project could be properly credited with the whole gain, wherever it happens to be. But in many cases an analysis of steam generation along these lines would reveal the possibility of taking several steps down the scale of costs before the economic limit of the existing plant was reached.

Reported Improvements May Mislead

One unfortunate effect of the impossibility of creating a universal scale by which all plants could be measured from an economic standpoint lies in the misleading conclusions that may be drawn from reported improvements. The size of the saving is as much a measure of past deficiencies as it is of present achievement, and often both starting and end points are left gracefully floating somewhere in a sea of miscellaneous coal values, but with the final efficiency determined, or at least reported, to the second decimal point.

Some point near 5 in our hypothetical scale represents the ultimate objective of every plant. It has been pushed down considerably within the last five years by improvements in steam-generating equipment. For those who like a definite end-point for the scale, 100 per cent efficiency would bring the cost in the hypothetical case to 13.9c., which, of course, can never be reached. It is interesting, however, to compare the distance between this point and the perfectly attainable point 5, with the much larger range of coal costs between 5 and 1, within which the costs are determined principally by differences in operation.

The Effect of Freight Charges

The foregoing has all related, for sake of simplicity, to one location. It is possible to project each point toward both lower and higher total coal costs as the freight rate varies. This is shown in Fig. 2. It will be noticed that coal values affect the unit cost of steam slightly more the nearer the point of consumption is to the mines, while efficiency affects the cost increasingly in cents per thousand pounds of steam as the point of consumption is more distant. The result, it will be seen, is that the farther a plant is from the mines the more difficult it becomes to offset a higher efficiency by better coal values.

This peculiar shifting of the relative importance of coal values and efficiency, depending on the location of the plant, can be illustrated by the actual records of two plants which were situated near each other at a point to which the freight rate on coal was only a little over one dollar per ton.

One of them, operated at a moderate efficiency, was able to take advantage of the better coal values, and had a coal cost per thousand pounds of steam slightly below

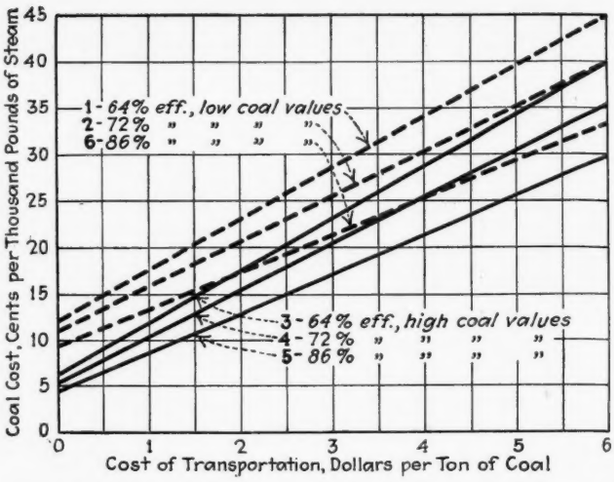


Fig. 2—Effect of transportation cost on steam cost

the other plant, which was operated at a substantially higher efficiency, but limited by plant design to low coal values. If these two plants had happened to be located at some more distant point, where the freight rate on coal was, say, $2.75, instead of a little more than a dollar, their relative economy would be just reversed, and the higher efficiency plant, in spite of its coal buying limitations, would be the low cost producer. From this it can be seen that the term "boiler and furnace efficiency" does not mean exactly the same thing, as an index of *economy*, at two different geographical locations.

[The third article by Mr. Gould, to appear April 21, will present case studies of plants that saved up to $20,000 yearly by applying these principles—Editor.]

▼ ▼ ▼

Another Oxide of Carbon

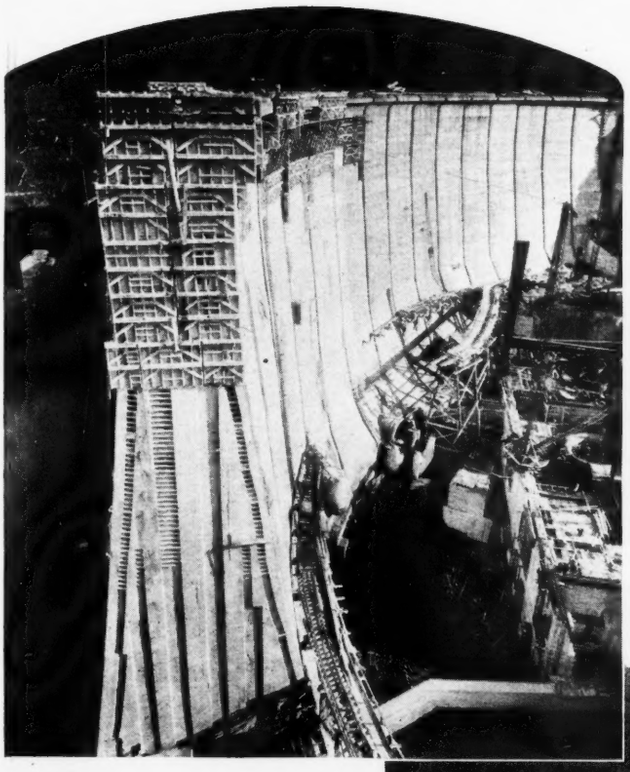
EVERY ENGINEER is acquainted with two oxides of carbon, CO and CO_2. Now comes the suboxide, described in the following quotation from a recent Arthur D. Little *Industrial Bulletin.*

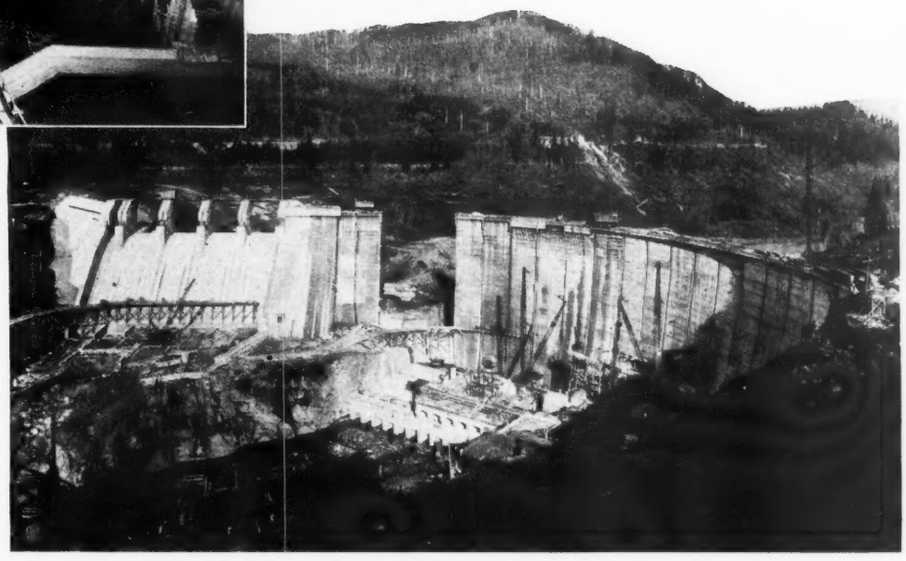
Familiar as both CO_2 and CO are to everybody, we now have to reckon with a third, the suboxide of carbon, C_3O_2, with which only a few chemists have as yet even a speaking acquaintance.

The suboxide is a gas at ordinary temperatures, but is easily condensed to a liquid boiling at 7 deg. C. and to a solid which melts at about 110 deg. C. below zero. It has an unbearable odor like mustard oil; its dilute vapor brings copious tears. In greater concentration it attacks the whole respiratory system with suffocating effect. It burns in air to CO_2, and with water it forms malonic acid. With ammonia, aniline and many other chemicals it unites to form a variety of compounds. Heated, it polymerizes to a dark red solid. Like many other laboratory curiosities it may one day find its place in industry.

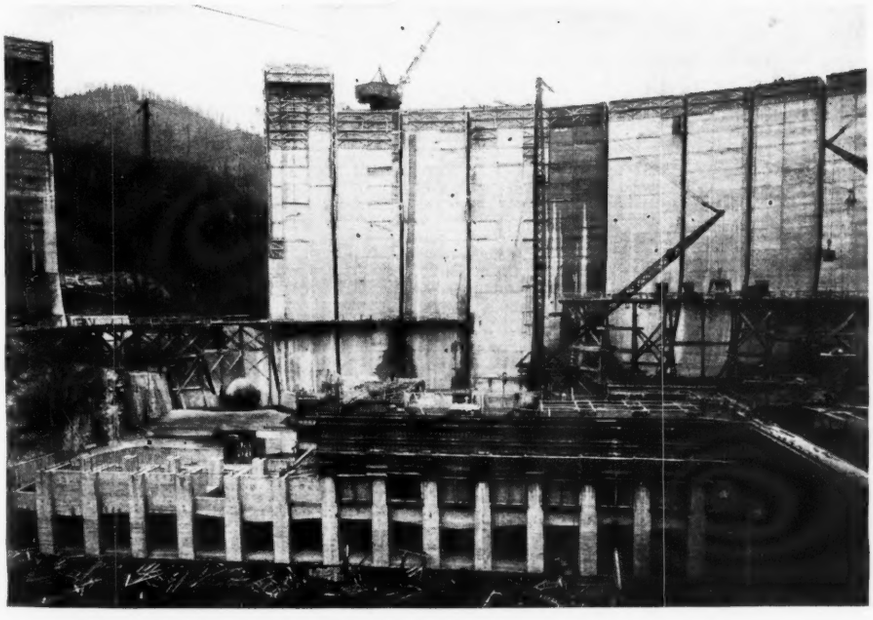
These three oxides of carbon afford a striking illustration of the extraordinary difference in properties which compounds of the same two elements exhibit as the proportions of the two constituents vary. We have another example in case of water, H_2O, and hydrogen peroxide, H_2O_2.

ARIEL HYDRO PLANT NEARING COMPLETION





Ariel dam of the Northwestern Electric Company, on the Lewis River near Ariel, Wash. This dam is 313 ft. high and is of the thin-arch type with a crest length 1,300 ft. The dam is being built in sections 30 ft. long with 2-ft. spaces between them, which will be filled 6 mo. after pouring the main sections. The keyways and slots in one section can be seen clearly in the picture



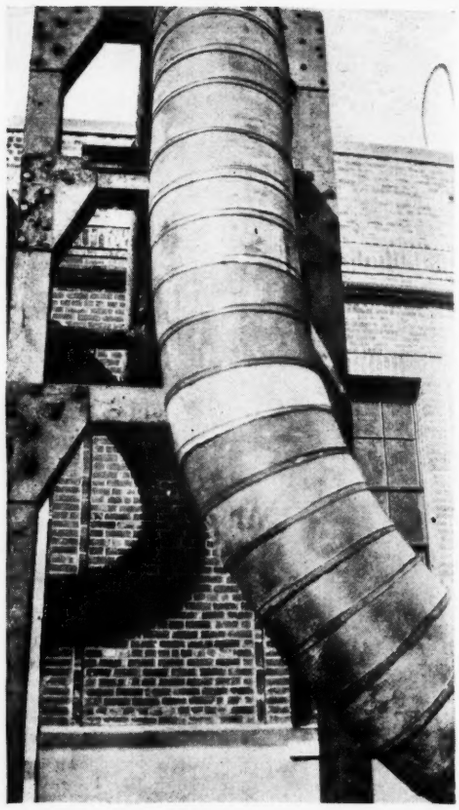
Above—The dam has a gravity type section, which can be seen on the left. This dam will form a storage reservoir of 220,000 acre-feet

Left—The power house is just below the dam and can be seen in the foreground partly constructed. It is designed for a total capacity of 290,000 hp. with an initial installation of one 61,600-hp. unit

Weather Proofing Insulation

Preceding articles of this series contained information regarding the raw materials used in the manufacture of present-day insulation and their characteristics, which have a direct bearing upon the limitations of the various types as discussed. This article is concerned chiefly with out-of-door and underground insulation

By E. F. ZEINER
Philip Carey Company



The start of a mile of steam piping weather proofed with roofing fastened on the pipe with copper clad wire

INSULATION applied indoors and under shelter is, for appearance's sake, usually finished with canvas sewed on or banded and painted with lead and oil paint. Flat and large-radii surfaces are often finished with a coat of hard asbestos cement and painted, or a heavy canvas jacket is pasted over the cement and it is painted. Often, when a particularly good-looking, durable, accessible job is desired on a flat surface, the insulation may be finished and inclosed in a casing of asbestos sheathing, usually about $\frac{3}{8}$ in. thick and constructed in paneled form.

Under sheltered conditions consideration need only be given to a heat-tight installation. Out-of-doors and underground, however, the insulation of a pipe line or tank also requires watertightness. The subject of suitable waterproofing of insulation exposed to the elements is of extreme importance from the standpoint of plant efficiency and operating costs, since wet or damp insulation is not effective in preventing heat loss.

The kind of weather proofing applied to pipe lines depends upon the conditions under which it is to be installed, underground piping requiring treatment different from outdoor piping above ground.

For this latter service metal jackets made of galvanized iron have been used extensively. This method of waterproofing is splendid where it is vitally important to cut down fire hazard, as in oil refineries. The first cost of the metal jackets, the difficulty in securing a thoroughly watertight job, and the expensive maintenance due to annual painting, are its chief disadvantages. Even careful attention and painting on the outside of the jacket does not always prevent corrosion on the inside and at the butt laps of the metal.

Pipe lines above ground have quite generally been waterproofed by wrapping prepared roofing felt around the insulated pipe, lapping adjacent sections of felt and wiring it securely in place. From a waterproofing standpoint, this type of installation is as good as its supervision. If the laps are liberal, sealed down carefully with lap cement and further reinforced by an occasional staple, a satisfactory job should result, provided, of course, copper wire is used and the longitudinal joints are arranged to shed water. Because the roofing jacket is asphalt saturated and coated, this type of waterproofing presents a remote fire hazard, which should be recognized. The use of an asbestos base roofing instead of the somewhat cheaper rag base material will decrease this fire hazard, but will not entirely eliminate it.

This method of waterproofing insulation has been improved upon from the standpoint of appearance and more positive watertightness, in recent years, by using heat-insulating materials to which a prepared roofing jacket has already been cemented, in place of the usual canvas. The prepared roofing jacket used in this type of installation requires attention at intervals of three to five years, when the roofing should be well painted with a blend of asphalt with which a large percentage of asbestos fiber has been mixed.

A means of waterproofing pipe lines combining something of the advantages of the two preceding systems is offered in metal-foil-surfaced roofing. The use of this material is not as yet very extensive. The waterproofing consists of a thin foil of non-corrosive metal, such as aluminum, zinc, etc., bonded to an asphalt-saturated roofing felt. This combination is applied in either of the manners outlined above, with the metal foil surface exposed to the weather.

Waterproofing of this type cuts down the fire hazard of the ordinary prepared-roofing installation to a minimum, and at the same time eliminates the paint job required annually by the galvanized-steel metal jacket. A greater use of metal-foil protection can be expected

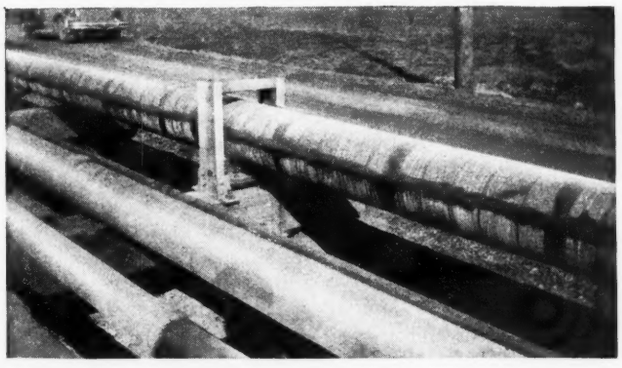
as engineers become familiar with the availability of this type of waterproofing.

The old method of waterproofing pipe covering by sewing on eight-ounce canvas and painting it with lead and oil paint or asphalt fiber coating has gradually been supplanted by one of the preceding methods. This change has been due to fire hazard and the annual painting required to keep the lead and oil job watertight.

Waterproofing Underground Insulated Pipes

The proper waterproofing of underground insulated pipe lines is a broad subject. A decision as to the best system of waterproofing can only be made after consideration of the particular conditions involved, having in mind the type of soil, its tendency to shift, the average percentage of moisture, the period of operation and first cost. One factor not often considered, but an expensive item, is the size of the trench necessary for the proper installation of the system. Hand in hand with the size of the trench in moist ground goes the cost and amount of pumping equipment necessary to keep the trench dry during erection.

Prepared roofing, "straight-away" and spirally wound, has been used as a waterproofing for underground pipes. The average installation has not proved satisfactory, because extreme care must be taken to waterproof all



A straight run of pipe protected from the weather by roofing material. Circumferential joints are about 3 ft. apart overlapped 2 in. The longitudinal joint is sealed with lap cement and reinforced with staples

joints thoroughly and then to coat the finished installation thoroughly with hot asphalt or hot coal-tar pitch, under side of line as well as top.

The old wooden box built up around an insulated piping is being discarded, because even though the wood may be creosoted the moisture will warp it and it will rot in the presence of heat and moisture. These actions cause the box to open up, the pipe covering is wetted and the purpose of insulation is defeated.

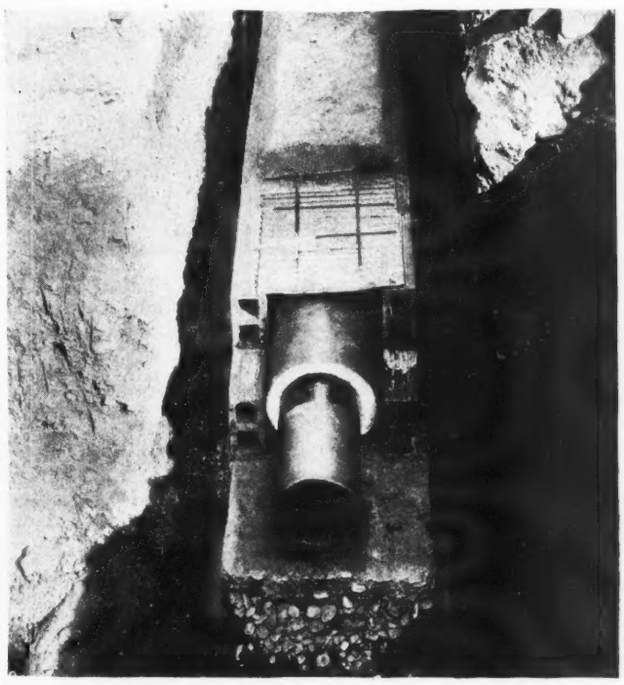
A third system of waterproofing that has been used to a limited extent employs one material for both heat insulation and waterproofing purposes. The material consists of vitrified air-cell sectional pipe covering applied in double-layer construction with all joints broken and cemented. This method may be reasonably satisfactory in dry soils and for low-temperature pipes, but the nature of the insulation is such that it is less efficient from a heat-saving standpoint if permanently watertight under operating conditions.

There are three systems of waterproofing underground pipe insulation in general use today. In the system suitable for large-sized pipe lines, and usually employed for the distribution of steam for heating and power purposes, the bottom of the trench is laid with concrete, which may or may not be reinforced. The piping is carried on roller supports laid in the concrete floor to permit expansion and contraction. Expansion joints are installed and anchored in concrete manholes located along the line and at changes of direction in the piping. The piping is insulated with covering around which prepared roofing material has been cemented. The sides of the duct are then built up of hollow tile bonded together with cement. The roof of the duct may consist of wood planking over which light concrete is poured to a few inches of thickness or a concrete slab may be cemented in place. Drainage is provided from the duct into the manholes from which seepage is disposed of.

The other two systems are more suited to industrial and small central heating distribution needs. In one of these the waterproofing medium is split-tile conduit with patent joints which depend for their watertightness upon a cement seal. Systems of this type have been used in which heat insulation was attempted by means of a sponge filler packed into the conduit, but not fastened to the pipe. In another case, the insulation was applied integral with the inside of the tile conduit. In the first case there is a tendency for the filler to pack down, leaving an air space between the top of the filler and the conduit, through which heat may be lost. Underground insulation integral with the conduit requires thicker insulation for equal efficiency, because of the increased surface from which heat may be lost.

The pipe covering used in these systems is more effective if applied directly to the pipe and the tile relied upon only to prevent an undue amount of moisture from getting into the insulation. When properly applied, and with care taken to cement the joints carefully in the tile, these systems are satisfactory. One advantage is that more than one line of pipe can be carried in the same conduit.

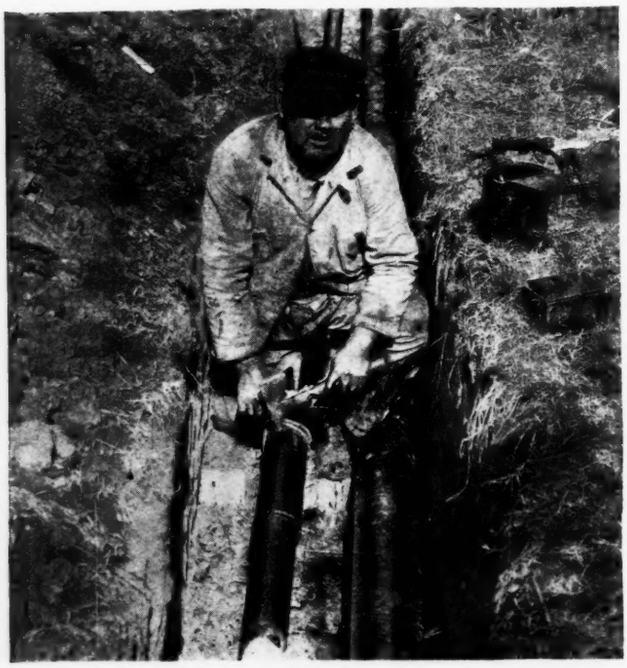
The other system of insulation for underground pipes that should receive consideration is markedly different



Underground steam distribution mains are often placed on concrete and a tile enclosure built around them

from those previously discussed. Here the insulation, usually of the molded type, is applied directly to the pipe. Waterproofing is effected by two shells of a specially prepared waterproof material. Each shell, which is from $\frac{1}{4}$ to $\frac{1}{2}$ in. thick, depending upon the pipe size, is split on one side only. The longitudinal and butt joints are carefully stapled together. Before applying the outer shell, in broken-joint construction, the inner shell is thoroughly coated with suitable waterproofing paint. The outer shell is applied and drawn tightly together by means of a rope in the form of a torniquet and stapled. The outer shell is then painted in the same manner as the inner one, but if the conditions of moisture are excessive a coating of hot coal-tar pitch is mopped on instead of paint. Suitable means of insulation and waterproofing are provided for fittings and flanges. Expansion and contraction within the covered pipe is taken care of by patented roller supports.

The bottom of the trench is filled with at least six inches of crushed stone, and in cases of excessive moisture sewer tile laid with open joints is incorporated in the crushed stone for improved drainage. For pipes over three inches in diameter the system provides for concrete piers at fifteen-foot intervals to carry the load of the line and to provide for anchorage at points of



Applying two layers of waterproof shells to underground pipe. The shells are split on one side only and the joints are staggered

direction change. Fittings and expansion joints are located in small concrete manholes, which are necessary with all systems.

The method employed to waterproof insulation on tanks, stills, and other pieces of equipment exposed to the elements has been of the same general nature as that used for pipe covering. The details of erection vary with the methods, and often within the same method; the individual conditions of the equipment, and opinions of engineers and erectors all play a part in the final installation.

Prepared roofing nailed or cemented directly to asbestos cement finish or nailed to batten strips set in the asbestos cement at intervals still is a means of protecting insulation from the weather. This method may be entirely satisfactory in a location where there is little likelihood of its damage. Care should be taken to seal all lap joints carefully and to arrange them to shed water. It may be found advisable to reinvigorate the prepared roofing with a coat of asphalt fiber every three to five years.

The use of plastic cement composed chiefly of an asphalt composition mixed with asbestos fiber is quite universal. The usual procedure has been to trowel the waterproofing on the primed, hard, asbestos cement finish of the insulated surface to a depth of approximately $\frac{3}{16}$ inch.

Experience has proved that the waterproof cement should be reinforced by means of one-inch hexagonal galvanized wire mesh securely tied outside of the hard asbestos cement finish. This wire mesh reinforcement is necessary to prevent localized cracking in the waterproofing cement and to counteract any tendency of the waterproofing to slide during excessive summer heat. When mesh is used to reinforce the waterproofing cement it should be covered by at least $\frac{1}{8}$ in. This method of waterproofing is quite satisfactory, relatively inexpensive and damage to it can be easily repaired by inexperienced men.

The use of asphalt fiber coating applied by a large brush to the primed, hard asbestos cement finish has been made extensively in some parts of the country. This method is faster than troweling on the asphalt waterproofing cement and somewhat less expensive in first cost. A surface waterproofed in this manner will require additional coats of fiber every three to five years.

The asphalt fiber coating is readily applied over canvas or waterproofing fabric, which may be used as a finish on small surfaces and over hair felt on refrigeration equipment.

Asphalt emulsions have come into extensive use during the past three or four years for waterproofing surfaces exposed to the weather. Some of the emulsions can be applied by brush directly to the partly dry asbestos cement finish over the insulation and themselves act as a primer for the asbestos cement. At least three coats of asphalt emulsion should be put on for a good job. Additional coats should be applied at two- or three-year intervals.

Where heavier waterproofing is desired asphalt emulsion mixed with sand or asbestos fiber can be troweled over the primed asbestos cement finish. The waterproofing should be reinforced by one-inch hexagonal galvanized wire mesh as previously recommended. Emulsions have the advantage over asphalt coatings and cements in that they are somewhat more fire-resistant.

Galvanized steel sheeting installed in many different ways is used to some extent. Steel alloyed with noncorrosive elements is preferable, although these sheetings may require painting at frequent intervals and are expensive. Sheet aluminum, usually about 20-gage, has been receiving consideration lately and has been used as the waterproofing for fractionating towers by one large manufacturer of oil-refinery equipment. This method of waterproofing is relatively expensive, but it seems entirely justified from a point of view of long life, attractive appearance, low heat emission and low maintenance charges.

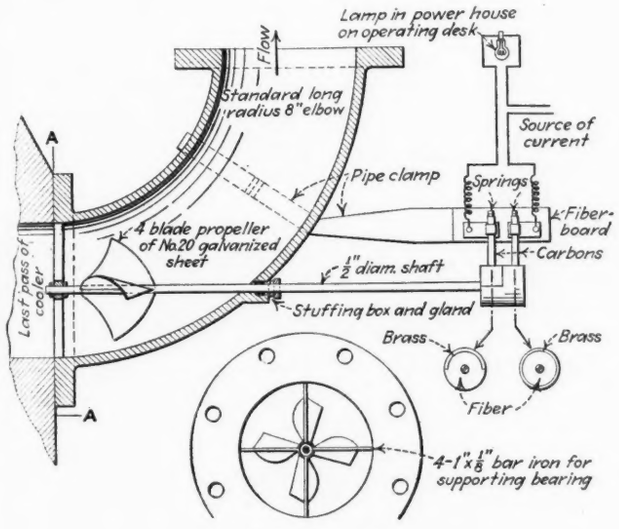
[The next and concluding article will deal chiefly with a consideration of suitable heat-insulation specifications.—EDITOR.]

...RIGHT OUT OF THE PLANT...

Flow Indicator Obviates Freezing of Brine in Coolers

WE HAVE HAD considerable trouble in our packing plant from the coolers freezing up, causing delay and sometimes expensive repairs. The coolers are of the inclosed shell-and-tube type, with six passes, each pass consisting of a bundle of 42 2-in. diameter tubes. Each cooler is of 150 tons' capacity, and four of them are connected in a battery.

The circulation indicator shown in the sketch was developed to warn the engineer when a cooler is in danger of freezing up. Whenever the electric lamp, corresponding to one cooler, remains bright or dark for any length of time, the man in charge knows something is wrong and can take the proper precautions.



Front Elevation at A-A

Details of indicator to show when circulation stops in cooler

When the lights of each of the coolers oscillate at the same rate the battery is giving the best performance.

ADOLF VON EUW,
São Paulo, Brazil — Armour of Brazil Corp.

Government Purchase of Foreign Diesels

THE EDITORIAL in the Jan. 27 number of *Power* on the purchase of foreign diesels by the United States Government was most timely.

I believe I can speak with some degree of experience, inasmuch as I held a commission in the United States Navy during the World War as an engineering officer on both reciprocating steam engine and turbine ships and since the war have had considerable experience in the operation of municipal light and power plants using diesel engines. This experience has naturally presented the various phases of economy and maintenance, operation and upkeep.

Why the American Navy and Shipping Board has been so reluctant to install and convert our ships to diesel drive when foreign powers have long since accepted its entire dependability has always been a source of wonderment to me.

I have gone to some trouble to examine the latest developments and improvements in both domestic and foreign engines. I can see no merit in the assertion that the American diesel engine industry has failed to meet the demands upon it, no matter how exacting these be.

In 1929 I visited the Beloit, Wis., plant of Fairbanks-Morse & Company. At that time they had on the test floor a large order of light, high-speed diesel engines for the Russian Government. These engines were undergoing a rigid test. If a European nation finds American engines satisfactory, some explanation should be made as to why our government thinks it must send to Europe for diesels.

True, a large percentage of the existing diesel power is concentrated within the mid-continent section of the United States; but while most of these engines are for stationary work, from an operation standpoint I can see no difference from marine operation.

As has been asserted before by opponents of American diesels, some initial failures have occurred; but that is no discredit to the American-built unit. It is apt to occur to any type of mechanical construction.

It is a well-known fact that in the operation of every new ship there is a "shakedown" run in order that the various working parts may adjust themselves. Such breakdowns as may have occurred on the Shipping Board vessels are no more frequent nor more serious in nature than similar occurrences in the operation of steam units.

Because of the various technical arrangements between American and foreign manufacturers the latest developments are easily acquired. I do not believe that the Navy Department or the Shipping Board is using good judgment in appropriating American dollars for the purchase of foreign goods when American industry is languishing for such orders and the quality of the foreign product itself is questionable.

Woodward, Okla. — H. M. RENNER, *City Manager.*

Bracing Coil Ends of Stator Windings

TO PREVENT coil end movement in the stator windings of large motors adjacent coil ends can be tied or taped together on both the upper and lower layers of coils. One or more rows of these bands can be used, depending upon the coil end extension.

Fig. 1 shows how surgical tape bands are applied on the coil ends. Filler or distance pieces cut to a shape as shown at *B* are placed between adjacent coils. The number and thickness of these pieces between coils are selected to make a tight fit. The spacers are cut to a shape to prevent them from slipping out from under the tape band. The bands are made with two or three turns of 0.020-in. thick x 1-, 1¼- or 1½-in. wide surgical tape. Torpedo twine can be used if an extremely tight band is wanted, as in Fig. 2.

When tape is used, bands can be made single, that is, started and finished at each band, or a number of bands can be made with a long length of tape, by taking a turn around the adjacent coil end before starting the next band, Fig. 3. All the tape ends should be sewed and each band painted with a clear baking varnish. The bands should be applied to both layers of coil ends.

When the coil ends of a winding give indications of movement during operation, the application of tape bands and filler pieces will reduce the movement and prevent damaged windings.

A. C. ROE.

Wilkinsburg, Pa.

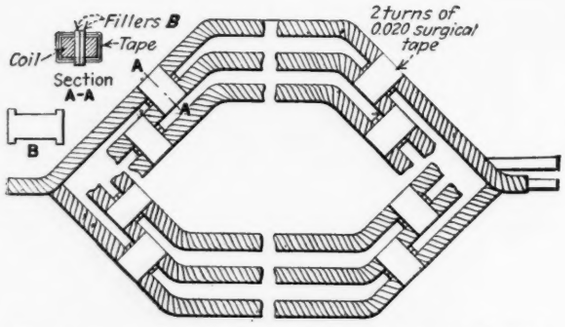


Fig. 1—How surgical-tape bands are placed on coil ends

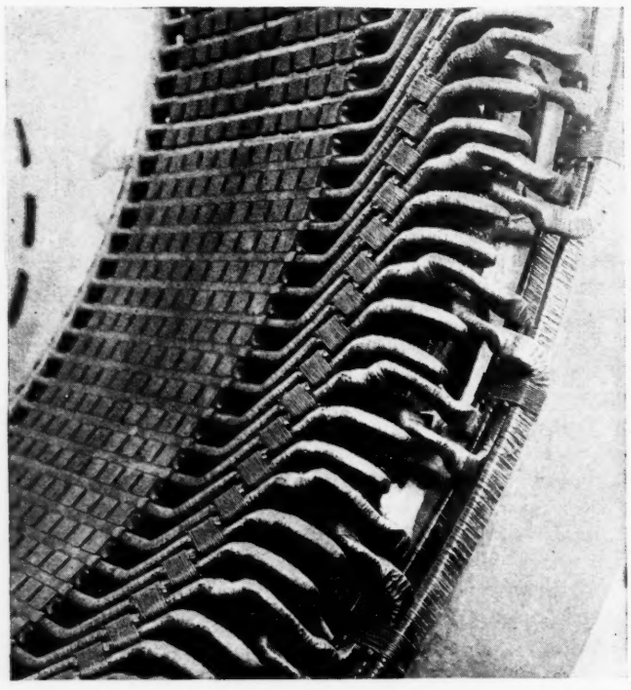


Fig. 2—Torpedo twine bands are used where very tight bands are required

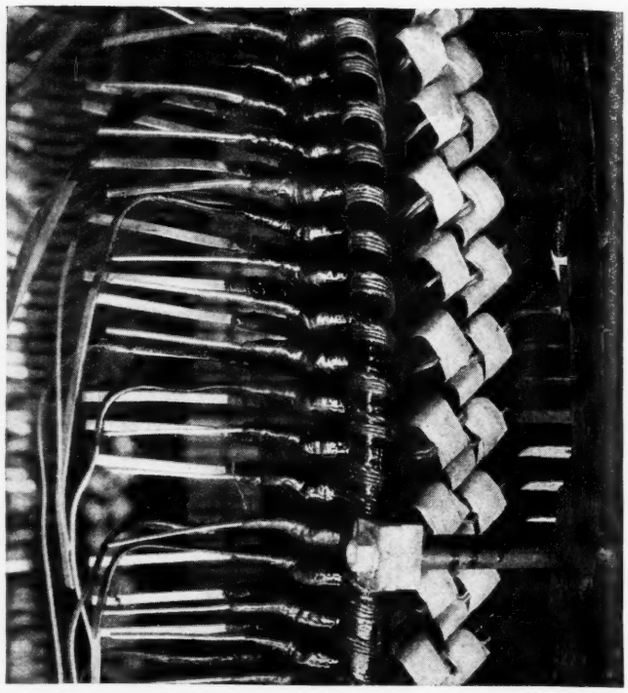


Fig. 3—Bands made up of one long piece of surgical tape

Grouting a Compressor Bedplate With Molten Metal

SOME TIME AGO I was supervising the installation of a large duplex air compressor, direct connected to an engine-type direct-current motor. The unit was to be mounted on a foundation fabricated from structural steel which rested on piles supporting the structure of the compressor house. This gave the foundation an elevation of about 30 ft. about the point where the piles entered the mud below. The space between the compressor frame and structural-steel foundation was to be grouted with antimony lead, or "type metal."

As work was in progress in December in an unheated room, with temperatures below freezing, naturally the compressor bedplates and steel foundations were cold, and although the type metal was heated to almost white heat, it would run under the compressor frame only about ⅜ in., then chill, shrink and set almost as soon as it was poured, being easily removable with the fingers after it had cooled.

It was deemed inadvisable to heat the compressor frame or foundation with a torch, because of possible cooling strains that might be set up, as only a small portion of the frame and structural steel foundations could be heated effectively at one time.

After considerable experimenting we built up a dam of wet clay on the steel foundation around one side of the frame. The type metal was then heated as hot as possible. Kerosene was poured under this side of the compressor frame and ignited, and as soon as this first amount was burned additional kerosene was poured in

and ignited. Immediately after the second amount of kerosene had burned out another pouring of kerosene was made and the red-hot type metal was poured into the gates at the several points provided for it.

The kerosene was ignited by, and burned ahead of, the molten type metal being poured, giving just enough heat to keep the metal molten until it had penetrated under the compressor bedplate nearly to the center, the heat being supplemented, of course, by the small amount of heat absorbed by the previous burnings of the kerosene. These heatings by kerosene removed the chill from the compressor bedplate and steel foundation without heating them dangerously. We were careful at all times to see that the space between the compressor bedplate and foundation was sufficiently vented.

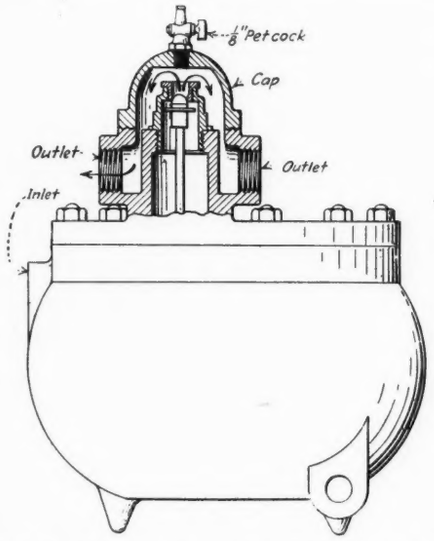
By grouting one side of the compressor frame at a time we found we were getting a good job and soon had the unit securely grouted. After a year's continuous operation, the grouting is still intact and solid even though the whole structure of the compressor house moves and vibrates considerably when the machinery is in operation.

Boston, Mass. J. W. REYNOLDS, JR.

Checking the Operation of a Steam Trap

IN INDUSTRIAL plants where a large number of steam traps are in service it is the usual practice to check them over once a day or at certain intervals to see that they are working properly. This is usually done by opening a valve or removing a plug on the discharge line to see that no steam is blowing through.

Having a number of traps of the general design shown in the illustration, we facilitated the checking of the



Pet-cock in cap over discharge valve facilitates checking operation of trap

operation of the various traps by drilling the cap over the discharge valve and installing a ⅛-in. pet-cock as shown.

This is more readily done and is less expensive than making provision for a valve or cock in the discharge line. EDWARD B. BACK.

Jeannette, Pa.

Proper Fusing of Circuits Prevents Power Interruptions

FUSES lend themselves readily to abuses. They can be improperly filled, which may lead to overloading the equipment they are to protect or cause the fuses to fail at loads below their rating. These abuses frequently lead to unsatisfactory operation, when a little care and a few minutes' effort could correct the defects.

Pitted fuse clips should be replaced, because it is almost impossible to repair them, the tension being usually destroyed by the arcing and heat of poor contact. A fuse may not be loaded near its capacity but still fail from local heat due to poor contact. Pitted contacts are caused by overloaded fuses, over-fused clips and dirty fuses. Often the clips will be found to make contact on one side only. This condition may be remedied with a pair of pliers and a little care.

In refilling fuses care should be taken to brighten the contacts with a fine emery cloth. A screwdriver should be used to tighten the ferrules or the link screws, because a firm contact cannot be made with the hand alone They should not be made too tight. If the contact points or surfaces in a refillable fuse are pitted so that a fine file will not smooth them, it is cheaper to replace them than to risk a delay caused by a blown fuse.

The main fuses in a distribution box should seldom blow. The smaller fuses should blow first and save the larger ones. If these do not, some circuit is overfused or the main fuses are too small, or they are not making good contact in the clips. I seldom use refillable fuses on the mains, because main fuses give little trouble when installed properly. GRADY H. EMERSON.

Birmingham, Ala.

Smoke Abatement

I READ the Foreword on "Smoke Abatement" in the March 3 number with considerable appreciation. It occurred to me that attention might have been called to the serious losses from corrosion of metals, etc., due to the sulphuric acid in soft-coal smoke particularly.

We are especially aware of the damage done by smoke through experience with water-cooling towers we have been installing during the past 30 years throughout the country. Most of the large cities require all-metal cooling towers, and we have been using galvanized iron for cooling surfaces and louvers.

We have found that, especially in the large railroad centers, like Pittsburgh and Chicago, the galvanized iron may last only about two years, whereas in localities that are free of smoke a life of ten years can reasonably be expected.

The conditions in the cooling tower are severe owing to the fact that the same water is circulated over and over again, and the surrounding air, with smoke, etc., must blow through the tower constantly to produce the necessary cooling. This results in a concentration in the water of the gases absorbed from the atmosphere. The damage, therefore, in a cooling tower is rapid and extensive. Undoubtedly all metal exposed to smoky atmospheres will deteriorate. The advantages of a clean atmosphere are much greater than suggested in the article.

EDWIN BURHORN

Bayonne, N. J. Edwin Burhorn Company

From Among Readers' Problems

Conducted by
L. H. MORRISON

Heating a Building with a Refrigerating Machine—*Is it possible to heat a building by operating a refrigerating machine?* C. MCW.

Theoretically, it is quite possible to heat a house in this way, but the practical application is handicapped by the size of the refrigerating machine required.

In any refrigerating machine heat is taken in by the evaporator at a low temperature, then raised to a higher temperature level and discarded in the condenser cooling water.

If we absorb the low-temperature heat from out of doors, raise its level by compressing the refrigerant vapor in a compressor, we may use the hot gases to warm the air within the house.

The illustration outlines the general idea. The system is better adapted to conditions when the outside temperature is not unduly low.

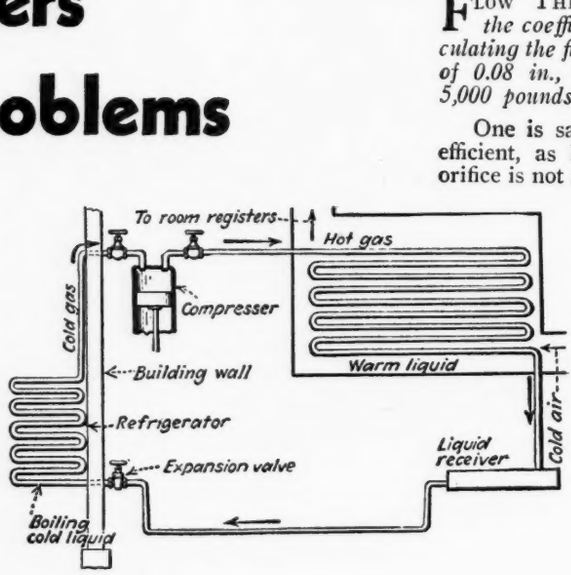
For example, let us assume that the house is heated by warm air and that part of the air is recirculated, so that the mixture of cold air and recirculated air is at a temperature of 60 deg. F. when it enters the heating compartment. Also assume that the warm air entering the room is at a temperature of 80 deg. F., which is ample if infiltration of cold air is kept at a minimum by double windows or weatherstrips. The outside air is assumed to be at 20 deg. F. The house, we will say, requires the burning of a maximum of 20 lb. of coal per hour at present, which with a fair boiler efficiency we will call 180,000 B.t.u., which is 3,000 B.t.u. per minute.

With the outside air at 20 deg. F., the ammonia in the evaporator coils should have a temperature of at least 10 deg. F., which gives an evaporator pressure of 23.8 lb. gage. The condenser would probably have a condensing temperature of 90 deg., since the cooling medium, air, is at 80 deg. F. The condenser pressure would then be 166 lb. gage.

At 166 lb. gage a pound of liquid ammonia will contain 144 B.t.u., and when evaporated at 23.8 lb. gage will contain 615 B.t.u., the difference; 471 B.t.u., is absorbed from the outside air. After compressed to 166 lb. gage each pound of vapor will contain 712 heat units. As the liquid ammonia at 166 lb. contains 144 heat units, the difference 712 — 144 = 568 heat units is used to heat the room air. So to give up 3,000 B.t.u. per minute the system must circulate 3,000 ÷ 568 = 5.28 lb. of ammonia per minute.

The work of compression is the difference in the heat contents per pound before and after compression, or 712 — 615 = 97 B.t.u. The 5.28 lb. would require 97 × 5.28 = 512 B.t.u. of compressor work. As a kilowatt is equivalent to 56.9 B.t.u. per minute, the compressor motor would have a rating of 512 ÷ 56.9 = 9 kw., or about 10 kw. input.

If the plant operated at full capacity ten hours a day for 30 days, the electrical consumption would run about 3,000 kw.-hr. At one cent per kilowatt-hour, the cost of the electrical energy would be equal to the cost of the three-tons of coal otherwise needed, at $10 a ton.



Schematic method of employing a refrigerating machine to warm a building by raising the cold outside air to a higher temperature level

Flow Through Orifice—*What is the coefficient to be employed in calculating the flow of oil through an orifice of 0.08 in., with a pressure of about 5,000 pounds?* M. T.

One is safe in using 0.8 as the coefficient, as long as the length of the orifice is not over five times its diameter.

Area of Safety Valve—*An engineering handbook contains the statement that the effective area of a 4-in. safety valve is the same as the internal area of a 1-in. pipe. Is this correct?* D.F.

The effective area of a value, assuming that the seat is at a 45-deg. angle is, 0.707 × lift × 3.1416 × diameter. The lift of an average 4-in. valve will be from 0.07 to 0.12 in. Thus the effective area becames 0.707 × 0.07 × 3.1416 × 4 = 0.62 sq.in. On the other hand, the transverse area of a 1-in. pipe is 0.861 square inch.

Increasing the valve lift from 0.07 to 0.097 in. will make the two areas equal.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

A 500-HP. synchronous motor drives two air compressors. When either one of the compressors runs idle the pointers on the alternating-current and the direct-current switchboard meters oscillate. When both compressors are working the meters are steady, which is also the case when both compressors are running idle. Suggestions as to the cause and remedy would be appreciated. A.L.

THE trouble is a result of the non-uniform turning effort required to operate any reciprocating compressor. This non-uniform turning effort is produced partly by the increasing force required to compress the gas up to the point where the discharge valves open, and partly by the force required to accelerate and slow down the reciprocating machine parts.

When a compressor is driven by a synchronous motor it is necessary to have a definite amount of flywheel effect to smooth out the irregularities in the turning effort. If the flywheel effect is too great, or too small, there will be a tendency to unsteady operation of the synchronous machine, and a condition may be set up wherein there is a cyclic

oscillation of the rotor on either side of its mean position of rotation.

This oscillation results in excessive power demand during part of the revolution and the return of some of this excess power (which has been stored up in the rotating masses) to the electric mains during another part of the revolution.

In the case under consideration no doubt the two air compressors are so arranged that the maximum and minimum turning efforts of the two machines do not coincide. If they are single-cylinder machines, presumably the cranks are placed at 90 deg. to one another, so that there will be four compression strokes per revolution, uniformly spaced. The flywheel effect incorporated in the rotor of the motor and in the additional flywheel, if any, has been designed for this condition.

When one compressor is unloaded and one is on load, the compressor has only two compression strokes per revolution instead of four, and consequently the flywheel effect is not suitable. If both compressors are on load the unit will run steadily, and if they are both unloaded, the unbalanced forces are comparatively small, and in any case not enough to cause any disturbances.

The oscillations noticed on the direct-current meters are caused by the surges impressed upon the alternating-current line by the cyclic oscillations of the synchronous motor.

The only way to correct the trouble, without making structural alterations to the machine, is to arrange so that both compressors cut in and out simultaneously. This may not be possible, or it may not be desirable for other reasons.

The whole question of flywheel effect on synchronous motors driving compressors has received a great deal of study in the last few years, and it is possible that the makers of the motor would be able to recommend a different value of flywheel effect which would satisfy the various conditions of operation with less disturbance to the line.

C. E. Olive,
Chief Engineer,
Canadian Celanese, Ltd.
Drummondville, Que.

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THE OSCILLATION of the pointers of the switchboard meters is evidently due to uneven load throughout one revolution when only one compressor is running. It would seem that the arrangement of the two compressors is such that they are meant to be working simultaneously and have their cranks at right angles to each other. Under these conditions there is a more even turning moment.

While the primary cause of the electrical disturbance is in the compressors, the trouble may be intensified by hunting of the rotary converter, or even in the synchronous motor, especially if either of these is of an old type. Again, if the direct current for the motor field is supplied by the rotary converter, when the high peak of load comes on the motor and pulls down the voltage throughout the system, the motor field is also weakened and the power factor of the motor becomes lagging, which further aggravates the trouble.

It is possible that the cranks on the compressors are without the balance weights necessary to reduce shock and vibration due to the inertia of the reciprocating parts. The maximum inertia corresponds to the centrifugal force of the combined mass of all the reciprocating parts and can be virtually neutralized by attaching an equivalent weight to the crank, opposite the crankpin. This must be done to both compressors.

It is most likely, however, that each crank is properly balanced and the pulsating load of each compressor, working singly, is the original cause of the variations. The remedy is to provide additional flywheel effect. The simplest and most convenient way of doing this is by means of two ballast rings on the rotor of the motor. This is a more compact arrangement than adding a flywheel on the main shaft and avoids stress reversals in the shaft between flywheel and motor due to load variations. The weight and method of attachment of the ballast rings should be determined by the makers of the motor, who have the particulars upon which all calculations must be based.

E. Scott Rivett.
Noranda, Que.

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Two Questions for Our Readers

1. We are interested in learning the experiences of other industrial plants in the burning of high-grade, low-volatile coals as compared with high-volatile slack in pulverized-fuel installations. We have been burning coals costing between $0.35 and $1.80 f.o.b. mines and seem to get the cheapest steam from 28 per cent volatile coals, costing $1.25 f.o.b.

C.B.F.

2. POWER in our plant is generated at 480 volts, 3 phases, 60 cycles and is supplied to the distribution centers by six 1,500,000-circ.mil single-conductor, cambric-insulated, lead-covered cables. These cables are 870 ft. long, are carried on a wooden structure and are supported in a vertical plane with the phases arranged A, B, C, A, B, C. With 480 volts at the power house and 600-amp. load on each set of feeders, the voltage at the distribution centers is 435. I should like to know how to reduce the voltage drop. Would placing the cables in each phase close together in a triangle improve conditions? Could iron brackets be used for supports?

E.B.T.

Suitable answers will be paid for and published in the May 19 number.

UNSTABLE operation of the 500-hp. synchronous motor with one compressor unloaded is caused by the very uneven torque required at the crankpin of the other compressor during each revolution. I assume that the set consists of a motor direct connected to the crankshafts of the compressors, each of which has high- and low-pressure cylinders in tandem.

Under these conditions the two crankpins are set 90 deg. apart to give as even crank effort as possible. Air compression in the cylinders makes the work done at different points of the stroke unequal. It is then impossible to obtain an absolutely smooth tangential effort curve. The motor rotor and flywheel have sufficient moment of inertia WR^2 to absorb these variations in torque, provided both compressors have similar conditions of operation.

Synchronous motors being constant-speed machines, the position of stator revolving field and rotor with respect to each other should not vary more than about 3 electrical-degrees in either direction. The rotating members must then have enough moment of inertia to prevent larger swings than this, or excessive line current fluctuations will result whenever the load during any revolution is unusually irregular.

With one compressor unloaded, the torque delivered by the motor changes from almost zero to maximum twice during each revolution. This causes excessive current variations, which are shown on the switchboard meters. If the incoming 2,300-volt line to the transformer bank is near capacity or overloaded, the current variations from the 500-hp. motor will cause dips in the line voltage. These, in turn, will reach the rotary converter through the transformer bank, causing the converter meters to oscillate with the same frequency as the compressor meters.

A remedy for this condition is to increase the size and weight of the flywheel on the compressor to furnish enough WR^2 to absorb torque variations with small angular displacement of the rotor. The compressor manufacturer can furnish information about the proper size and weight of flywheel.

E. W. MacCorkle, Jr.,
Kentucky & West Virginia Power Co.
Ashland, Ky.

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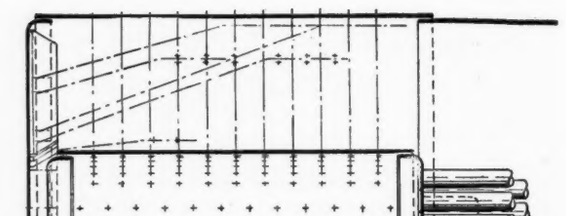
A Correction—In the No. 1 problem of April 7, the outer strap should have been 1⅛ in. and the drum diameter 48 in.—Editor.

Calculating the Working Pressure Of a Locomotive-Type Boiler

The answer to the following question is of such length that it could not be used in the "Among Our Readers' Problems" pages; but its interest value to many readers, it is felt, justifies its publication

THE BARREL, or cylindrical part, of a locomotive-type boiler, intended for 230 lb., of 60-in. diameter, 30-in. radius, is of ¾-in. firebox steel of 55,000-lb. tensile strength and has a triple-riveted, double-butt, strapped seam, with an efficiency of 85 per cent. The wrapper sheet is of ½-in. firebox steel of 55,000-lb. tensile strength and has a radius of 30 in. There is no longitudinal seam in the wrapper sheet, but the crown sheet of the firebox and the wrapper sheet are secured together by 1-in. dia. radial stays spaced 4x4 in. at the crown sheet. How is the working pressure found?



The type of locomotive boiler dealt with in this problem of wrapper sheet design and strength

IF THE radius of the shell of a locomotive-type boiler is the same as the radius of the wrapper sheet, and if both are of the same thickness and kind of material, the strength of the longitudinal joint of the shell plate determines the safe working pressure by application of the formulas in Par. P-180 of the A.S.M.E. Boiler Code. But to outline how the calculations should be made in cases where the plates are not equal, the question will be answered on the basis that it is desired to find the safe working pressure of the boiler based on the wrapper sheet.

The A.S.M.E. Boiler Code in Par. 212 states:

> The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:
>
> First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. P-199, using 70 for the value of *C*.
>
> Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in Table P-7 [of the Code], each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace.
>
> The maximum allowable working pressure for a stayed wrapper sheet of a locomotive-type boiler shall be determined by the two methods given above and by the method which follows, and the minimum value obtained shall be used:

$$P = \frac{11{,}000\ t \times E}{R - S\ \Sigma \sin \alpha}$$

in which

α = Angle any crown stay makes with vertical axis of boiler.
$\Sigma \sin \alpha$ = Summated value of $\sin \alpha$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.
S = Transverse spacing of crown stays in crown sheet, in.
E = Minimum efficiency of wrapper sheet through joints or stay holes.
t = Thickness of wrapper sheet, in.
R = Radius of wrapper sheet, in.
P = Maximum allowable working pressure, lb. per sq.in.
11,000 = Allowable stress, lb. per sq.in.

The first step is to apply the first section of the rule quoted. The weakening effect of the holes for the radial stays, which are 1 in. in dia. and spaced 4 in. apart longitudinally of the wrapper sheet, is found by subtracting the hole diameter from the pitch and then dividing by the pitch, or $\frac{P-d}{P}$ = per cent of solid plate or $\frac{4-1}{4} = 0.75$, and the strength of the section is then $\frac{\frac{1}{2} \times 55{,}000 \times 0.75}{30 \times 5} = 138$ lb. per sq.in., when ½ in. is the plate thickness, 55,000 the tensile strength, 5 the factor of safety and 30 in. the radius of the sheet.

The spacing of the radial stays along the wrapper sheet is 4 in. longitudinally, but the transverse pitch of each row of bolts depends upon its angularity.

Each radial stay is considered as supporting the crown sheet and the wrapper sheet for one-half the distance to the next bolts. For example: Radial stay No. 2 in Fig. 2 supports one-half the distance between stay No. 1 and stay No. 3, or $\frac{7+5}{2} = 6$ in.

The maximum pitch of the radial stays is 7 in., which is the distance between the stays in row No. 1 and row No. 2. The calculation, according to Par. P-199, becomes

$$P = 70 \times \frac{64}{49} = 91 \text{ lb.}$$

This amount added to the 138 lb. gives a total of 229 lb., the safe pressure found by the first method.

The second method likewise considers the strength of the net section of the wrapper sheet along the line of radial stay holes, which we have found is 138 lb. pressure. To this is added the pressure permitted on the stays according to Table P-7 in the code. The radial stays, having a length greater than 8 in., need not be provided with telltale holes, so the area of the bolt at the base of the thread is used in determining its strength. A 1-in. dia. bolt has an area at the base of the thread of 0.575 sq.in. and is permitted a safe load of 4,317 lb., or 7,500 lb. per square inch of cross-section as permitted by Table P-7.

As each bolt supports one-half of the distance to the next bolt in each direction, the area supported by each bolt in row No. 1 is

$$(4 + 3\tfrac{1}{2}) \times 4 = 30 \text{ sq.in.}$$

The strength of the bolt divided by the area it supports gives the safe load in pounds per square inch, or

$$\frac{4317}{30} = 143 \text{ lb.}$$

This amount is added to the 138 lb. already obtained, so the maximum allowable working pressure found by the second method is 281 pounds.

The third method, outlined in Par. P-212b of the code, is more complicated, and includes the determination of the sine of the angle made by each radial stay with the vertical axis. This method is suitable for drawing board use only, and measurements, if made of the finished boiler, must be plotted on drawing paper before the calculation can be completed as shown in Fig. 2.

The sine of the angle may be found with sufficient accuracy by extending the vertical axis above the wrapper sheet and below the crown sheet to include a distance of 6½ or 7 in. above the point *A*, where the projected line representing the center line of the stays in row No. 1 meets the vertical axis.

From the junction *A* lay off *AZ*, Fig. 2, a distance of 100/16 in., or 6¼ in., on the diagonal line representing the projection of radial stay No. 1. From *Z* measure the distance *ZY* at right angles to the vertical axis *AY*. Distance

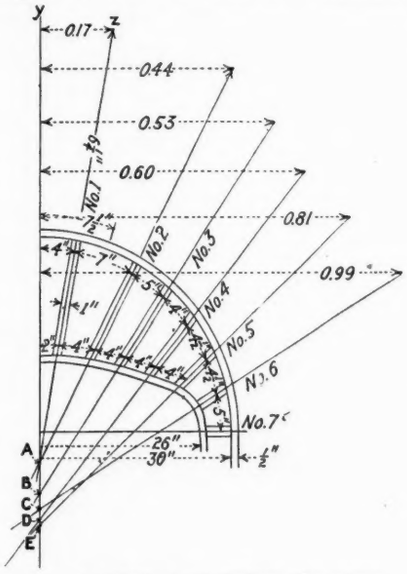


Fig. 2—Method of finding the sines of the stay angles

ZY, in sixteenths of an inch represents the sine of angle *ZAY*, in one hundredths, expressed decimally. The distance between *Z* and *Y*, shown in Fig. 2, is 17/16 inches; so the sine of the angle *ZAY* is *0.17*.

By the same method the sine of the angle for a radial stay in each longitudinal row is found and used in the following calculation:

Radial stay row	$S \times \text{sine } a$
1	$4 \times 0.17 = 0.68$
2	$4 \times 0.44 = 1.76$
3	$4 \times 0.53 = 2.12$
4	$4 \times 0.60 = 2.40$
5	$4 \times 0.81 = 3.24$
6	$4 \times 0.99 = 3.96$
Summation, or $\Sigma\ (S \times \text{sine } a)$	$= 14.16$

By the formulas:

$$P = \frac{11{,}000 \times 5 \times E}{R - \Sigma.(S \times \text{sine } a)} =$$

$$\frac{11{,}000 \times .5 \times .75}{30 - 14.16} = 260 \text{ lb.}$$

The minimum pressure was found to be 229 lb. and may be increased to 230 lb. by increasing the longitudinal pitch of the radial stays to 4.25 in., if the error is discovered before construction has started.

Calculating Crown-Sheet Strength

While the question does not involve the crown sheet, its strength must be calculated in an actual boiler. The crown sheet of the firebox of a locomotive-type boiler may be supported by radial stays used in the construction just considered. The curvature of the crown sheet is of such great radius that the problem of providing ample support to carry the maximum safe working pressure is solved by the application of Par. P-199 and P-220 of the code just as if the crown sheets were a flat surface.

But if the crown sheet is supported by either of those methods, the crown-sheet supports do not add any strength to the wrapper sheet, which must be of the same thickness and kind of material and have an equal longitudinal joint efficiency as compared with the construction of the shell plate of the cylindrical part of the boiler, when the safe working pressure would be found by the application of the formula in Par. P-180.

▼

Natural Gas Displacing Fuel Oil in North California

As a result of offering natural gas to industrial steam plants at a price competitive with fuel oil, the Pacific Gas & Electric Company of San Francisco, Calif., had secured on Jan. 1 310 contracts for an annual usage of 12,674,997,000 cu.ft. of natural gas, according to an article, entitled "Natural Gas Becomes a Prominent Factor of Industrial Development," by J. H. Gumz, published in the January issue of the *Pacific Service Magazine*.

"Translating this into terms of fuel oil, natural gas has been contracted for in place of 2,300,000 barrels of fuel oil being used annually," the article states. "This means that 38 per cent of the fuel oil being used industrially in the northern California territory served by the Pacific Gas & Electric Company (approximately 6,000,000 barrels were being used annually) has been changed to natural gas. Such a change in the use of fuel in less than a year and a half from the first arrival of natural gas in northern California surely justifies the statement that in but a short time natural gas will be used in industries to the practical exclusion of all other fuels. This is further justified by the fact that the fields in the San Joaquin Valley are today producing more natural gas than is required to replace every barrel of fuel oil being used industrially in northern California, and with the addition of compressor stations, the present pipe-line system is also adequate to transport all of the gas required to displace the fuel oil."

▼

Feed Water Arrangement At Berlin West Station

Some rather interesting features are incorporated into the feed water and make-up systems of the recently constructed West station, Berlin (Germany) municipal electrical system. The following brief comments are based on more extensive information given in the September and October, 1930, numbers of *Siemens Zeitschrift*.

Automatic Make-Up Control

The turbine condensate is first heated from 73 deg. F. to 90 deg. F. by the condensate of the steam taken from the main turbine at pressure varying from 22 lb. abs. at 34,000 kw. to 16.4 lb., at 27,000 kw. The final first stage heating temperature varies accordingly, the maximum being 203 deg. F. The varying pressure makes it necessary to provide a first-stage heater for each main turbine.

The heater thus becomes part of the turbine outfit and makes possible guarantees that cover not only the water rate, but the heat rate as well.

The second stage heating takes place in two vapor condensers. There vapor from evaporators raises the temperature of the turbine condensate to 272 deg. F. The third stage of heating is by steam extracted at 85 lb. abs. from the house turbine.

In the second heating stage already mentioned a direct relation is established between the make-up distillate produced and the station load. Should the unlikely occur, that the make-up demand is temporarily greater than that determined by this relation, more distillate could be obtained at the expense of a slight loss in station efficiency by bypassing the first stage heater.

Storage of Boiler Water

Perhaps the most interesting feature of this station is the arangement made to store excess boiler water accompanying sudden increases in load. Two hotwell tanks of 9,200 gal. each are provided. When the boiler-water level rises sharply, due to a sudden increase in load, a special valve permits some to discharge to the hotwell tanks. These tanks are connected with the 85.5-lb. abs. extraction-steam line. Any excess boiler water received flashes into steam and thus replaces a corresponding amount of extraction steam. On the other hand, if the condensate collected should have a temperature lower than 311 deg. F., steam will enter the tanks and maintain this temperature.

Two level-controlled pumps discharge the condensate to the main feed line past the third stage heater.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

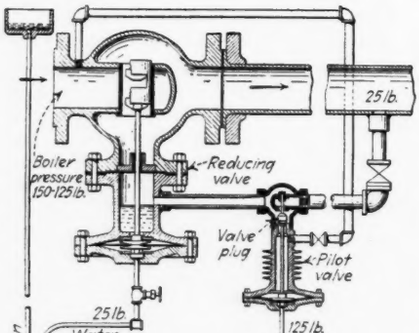
Pilot Valve Control of Reducing Valve Prevents Drop in Initial Pressure

TO PREVENT an excessive demand for process steam lowering the initial or supply pressure below a fixed minimum, the Mercon Regulator Company, 1 LaSalle St., Chicago, has attached a pilot valve to the standard Mercon reducing valve, as indicated in the accompanying drawing. The pilot valve functions when the supply pressure falls below a predetermined minimum and closes the reducing valve. Normal operation of the regulator is resumed when the supply pressure is restored.

Use of this auxiliary valve can best be understood from a typical application. For example, take an industrial plant in which the boilers supply steam at an average of 150 lb. pressure to operate turbines or engines, pumps and other equipment. A large amount of steam also is used at irregular intervals for process work. For this purpose the pressure is reduced to 25 lb. by one or more regulators of the type shown.

The system permits only steam in excess of 125 lb. pressure passing to the low-pressure system. A ½- or ¾-in. connection transmits the reduced pressure of 25 lb. through the wide open pilot valve to the upper surface of the regulator diaphragm. The diaphragm is balanced by a mercury column of sufficient height to exert a pressure of 25 lb. on the lower surface. The regulator consequently operates in the usual way and maintains 25 lb. reduced pressure as long as the supply or boiler pressure is above 125 pounds.

The diaphragm of the pilot valve is loaded by means of a mercury column, spring, or weight corresponding to the 125-lb. fixed minimum pressure to be maintained. Normally the pilot diaphragm is held down by pressure transmitted through a small pipe from the boiler or inlet side of the regulator, this pressure being sealed in by the valve plug seating on the lower seat ring. As soon as the supply pressure drops below 125 lb. the pilot diaphragm moves upward, the plug seats at its top and opens the lowest seat so that steam at about 125 lb. pressure flows from the supply line through the pilot valve and back to the upper surface of the main regulator diaphragm, thereby forcing it down and closing the regulator.



Pilot-controlled Mercon regulator

As the regulator closes, the supply pressure starts to rise. When it passes 125 lb. the pilot valve seats downward again and normal operation of the regulator is resumed. By proper design of the pilot valve and by throttling the needle valves in the mercury connections, hunting and surging are prevented. The regulator closes only far enough to prevent the supply pressure going below 125 lb., but with this restriction the reduced pressure may drop below 25 lb. until the demand is less or until the boiler pressure rises and stays above 125 pounds.

Other applications of this device are for two-pressure boiler plants where the excess of high-pressure steam may be used in the low-pressure system but it is desired to prevent the demands of the latter lowering unduly the higher pressure. Another application is on gas-distribution systems where a consumer must be prevented from lowering the distribution pressure to the detriment of other consumers.

1,000-Volt Insulation Tester

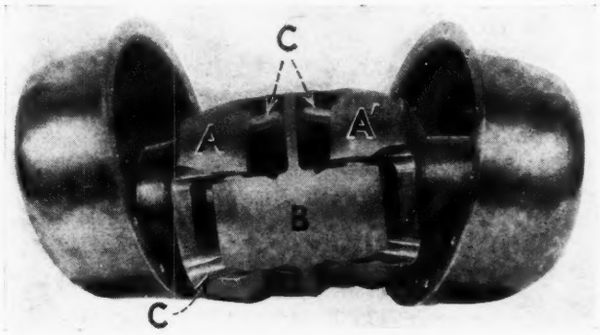
FOR TESTING practically all types of 440- and 600-volt equipment at a potential (1,000 volts) definitely higher than the working voltage, where the insulation resistance does not run over 200 megohms, a new 1,000-volt "Super-Meg" insulation tester has been introduced by James G. Biddle Company, 1211 Arch St., Philadelphia, Pa.

The instrument is similar in construction to the standard 500-volt "Super-Meg" insulation tester, but is slightly larger and heavier. It measures 5½ in. wide, 6¼ in. high and 9⅛ in. long and weighs 9 lb. The drive mechanism has the slip-clutch device by which a constant voltage is generated. The indicating portion of the instrument is a true ohmmeter and, it is claimed, is unaffected by the exact value of the voltage applied. Used on 220- and 110- and lower voltage apparatus the instrument provides a combined insulation resistance and high potential test.

"Super-Meg" insulation tester

Coupling Designed for Wide Angularity and Misalignment

DESIGNED to embody the features characteristic of the Weiss universal joint, a description of which appeared in the March 31 number, the coupling illustrated has been introduced by the Weiss Engineering Corporation, Grand Central Terminal Building, New York City, to cover a wide range of applications.



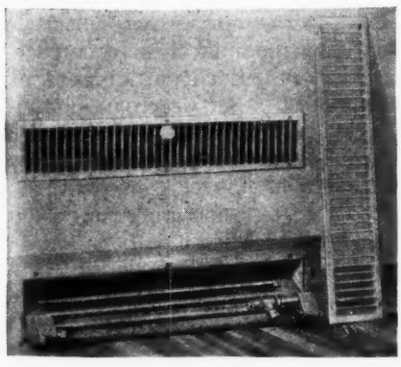
In the Weiss coupling balls provide free endwise motion and for changes in angularity and misalignment

The new coupling consists of three parts, two shaft hubs *A* and *A'*, a central member *B*, and a number of steel balls which not only provide the power transmitting medium between the members, but also allow for angular and parallel misalignment.

The balls move in races, as indicated at *C*, and provide free endwise motion as well as for changes in angularity and misalignment. With the type of housing as shown, the maximum angularity obtainable on the shafts is 12 deg., which is an included angle of 24 deg. The maximum amount of misalignment and maximum end motion is ½ in. If a greater end motion is desired the jaws of the joints can be lengthened.

Concealed Radiation

AN INNOVATION in heating equipment is the new concealed type of radiator recently announced by C. A. Dunham Company, Chicago, Ill. In order that the heating element be non-corrosive, it is constructed of seamless drawn copper tubes connected to semi-steel cast-iron headers by a brass clamping nut which forms screwed ground joints. The headers are cast in one piece, so that the entire assembly is made without the use of gaskets, soldering, brazing or welding. The copper tubes are wound with a continuous copper fin metallically attached to the tube by special lead alloy. The radiating fin is a smooth continuous spiral with no dust-catching hollows.



Heating element is readily removable

The casing of the radiator, which is adjustable in height, is concealed within the wall and provided with an aluminum grille top and bottom. By removing the lower grille and disconnecting the steam pipes, the complete heating element may be removed as a unit. Advantages claimed for the new unit are: ease of installation, accessibility, long life owing to the use of non-corrosive material in the heating element, and constant heating efficiency.

Fluxed Electrodes

A STABLE, smooth arc is said to be obtained with "Ductone" fluxed electrodes, announced by the Fusion Welding Corporation, 10257 Torrence Ave., Chicago, Ill. The new electrode it is claimed, permits carrying the rate of fusion as high as it is possible for an operator to handle with the metallic arc. The surface slag remaining on a weld is rather heavy, but it is quite brittle and strictly non-adherent when cold and can be brushed off readily. A long arc is employed, and the arc voltage may be double over that with a bare steel electrode. Tests indicate that the electrode will produce welds in mild steel possessing tensile strength of over 75,000 lb. per square inch.

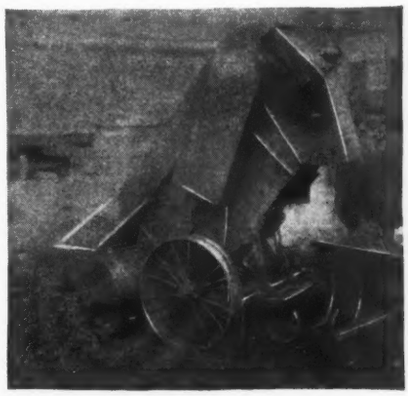
Ductone fluxing can be applied as a coating to various carbon and alloy steel rods.

Bucket Loader for Small-Size Coal

FOR HANDLING nut and slack coal in boiler rooms, loading conveyor hoppers, etc., a small bucket loader, Model 63, has been developed by the Barber-Greene Company, of Aurora, Ill.

Although designed primarily for small-size coal, the new loader will handle any bulk material which contains no greater than 4-in. lumps. Its small size when operating (7 ft. high, 6 ft. long, and 4 ft. wide) makes it suited to operation inside bins or box cars. It is self-feeding, crowding itself into the material by means of a pawl-and-ratchet feeding mechanism. By reversing the pawl, the feeding drive is reversed for backing out of the material. A simple arrangement on the pawl and ratchet makes five speeds available in either direction.

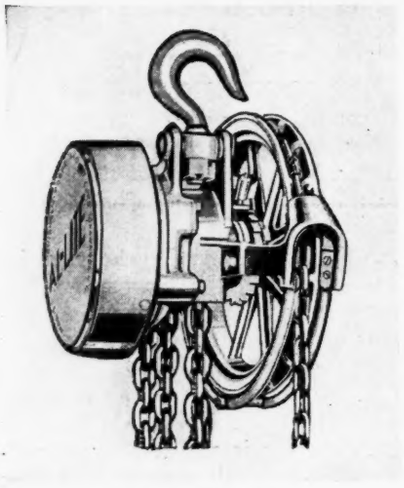
The feeding device is of the spiral-ribbon type, with a ribbon 24 in. in diameter. The bucket line is composed of special welded steel buckets and is totally inclosed to eliminate unnecessary dust. Two 30-in. roller bearing wheels with a 6-in. face and a 10-in. roller bearing caster wheel for steering are the mounting for the loader. A 5-hp., ball-bearing, totally inclosed motor is the driving unit.



Model 63 self-feeding loader

Chain Hoist of Aluminum Alloy

"AL-LITE" is the name given to a new aluminum-alloy chain hoist recently brought out by the Chisholm-Moore Hoist Corporation, Towanda, N. Y. Being one-third lighter than the regular chain hoist for the same capacity, the new hoist



Al-Lite chain hoist

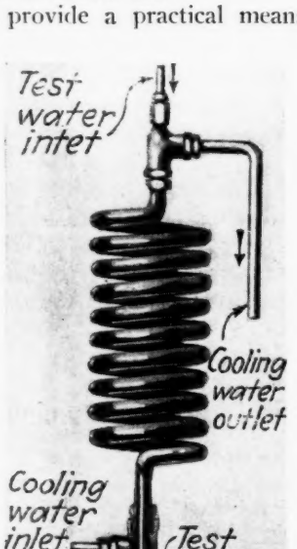
is more easily handled and hung in place by one man.

Some of the important features pointed out by the manufacturer, in addition to lightness and portability, are simple design, easy accessibility, planetary type gears, adjustable positive action brake, corrosion resistance and use of "Inswell" chain with 50 per cent overload test.

Test-Water Cooling Coil

IN THE modern power plant the sampling of steam and water at various points in the power cycle has become an important part of the regular operating routine. It is essential that a hot sample be cooled to room temperature while still under pressure, to avoid flashing when the sample is drawn off.

To provide a practical means of obtaining test water samples and cooling them to room temperature, the Bailey Meter Company Cleveland, Ohio, has brought out the test-water cooling coil illustrated.

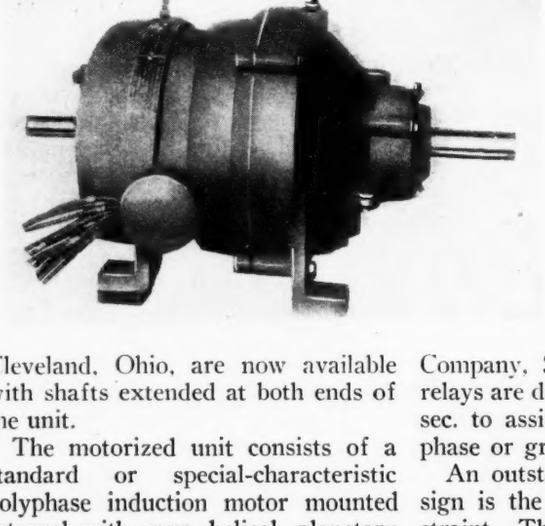


Cooling coil for pressures up to 1,500 lb.

The cooling coil, which consists of a tube within a tube, is made from copper tube and "Dieform" compression fittings. In operation, the hot test sample enters the smaller inner tube at the top, while the cooling water enters the outer tube at the side outlet on the bottom. Cooling water completely surrounds the inner tube as it passes upward through the annular space between the tubes to the side outlet at the top, or, in other words, the coil operates on the counter-flow principle. Coils are designed for working pressures up to 1,500 pounds.

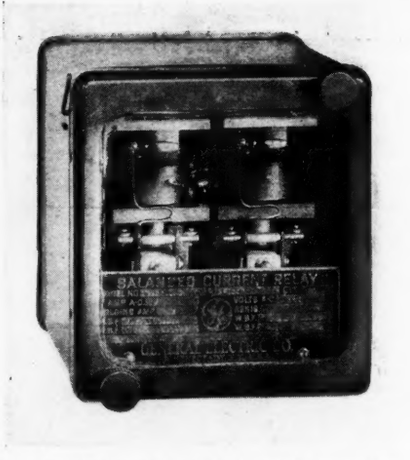
Motorized Speed Reducer

ALL MOTORIZED speed reducers manufactured by the Production Equipment Company, Cleveland, Ohio, are now available with shafts extended at both ends of the unit.



Motor is mounted integral with speed reducer

The motorized unit consists of a standard or special-characteristic polyphase induction motor mounted integral with spur, helical, planetary or bevel gears retained in an oil-tight housing. The low-speed shaft, from the speed reducer end, provides a speed as low as 20 r.p.m. or may be supplied with a speed of as high as 875 r.p.m. The opposite shaft, direct from the motor, provides high speed of standard polyphase motor speeds of 1,800, 1,200, 800 or 720 r.p.m. For certain applications the unit can be supplied with speed reducers at both ends, thereby giving opposite shaft speeds alike or different from each other. With the various speeds possible through the selection of gears of different ratios and motors of different speeds, practically any driving requirement can be met.



Relay designed for high-speed operation

New High-Speed Relays

A LINE of high-speed, selective, balanced-current relays, designed especially for use on alternating-current parallel lines where stability is dependent upon high-speed operation of protective devices, is announced by the General Electric Company, Schenectady, N. Y. The relays are designed to operate in 0.008 sec. to assist in clearing a phase-to-phase or ground fault.

An outstanding feature of the design is the novel use of voltage restraint. This allows operation at well below full-load current of the circuit. It also permits the switching of individual transmission lines without the usual special operating rules.

The relay comprises two balanced-beam units mounted in a rectangular case 5½x6 in. Each unit consists of an armature, a set of circuit-closing contacts and four coils. Under normal conditions the relay contacts are open. Under faulty conditions the pull of a current-operating coil in the faulty line exceeds the pull of its voltage restraint by closing the contacts to trip the breaker of the faulty circuit. The contacts are then sealed closed by the holding coil until the breaker opens its auxiliary switch.

NEWS of the FIELD

Why the Mercury Unit at Hartford Is Down

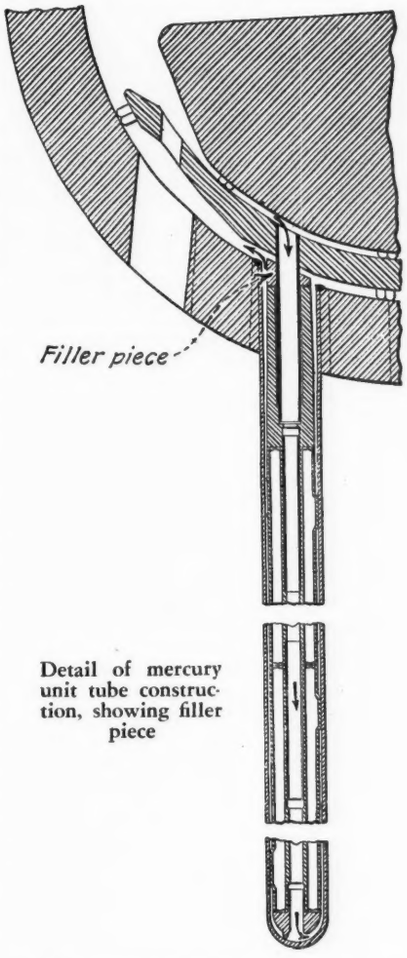
AFTER A YEAR of practically continuous operation, marked by economies beyond expectation, the mercury unit at the South Meadow Station of the Hartford Electric Light Company has been shut down for retubing. The immediate cause of taking the unit out of service was the development of a slight leak in one of the tubes, accompanied by some bulging in others. Detection of the leak was almost instantaneous by the selenium-sulphide coated ribbon which, in combination with a photo-electro cell, sounds an alarm if any mercury vapor is present in the flue gases. So sensitive is this detector that it will indicate when two cubic centimeters of mercury is thrown into the furnace with the boiler under full load.

Investigation has shown that mercury had nothing whatever to do with causing the leak, but that it was brought about solely through failure of a small mechanical detail. Referring to the sketch, it will be seen that there is a loose-fitting cast-iron filler-piece, which surrounds the upper end of each inner tube. Vibration apparently set up repeated movement to the filler-piece. This caused minute particles of cast iron to deposit in the small annular space between the outer and inner tubes. Circulation was impeded and over-heating resulted. In a few instances the movement of the cast-iron filler-piece had caused the bottom inner edge to wear away and finally puncture the top of the inner tube.

There was also some indication of movement of the inner tube itself, in that the lugs which serve to keep the inner tube central with the outer tube were worn.

In retubing, the arrangement is being modified so as to eliminate the filler-piece and do away with all loose fits. Tests on these tubes indicate that they will have a higher vapor producing capacity than the tubes which are being replaced.

Advantage is being taken of the opportunity, while the unit is down, to disassemble the turbine and subject it to a thorough inspection. Through the courtesy of T. H. Soren, vice-president of the Hartford Electric Light Company, an editor of *Power* was privileged to examine the unit while it is down. It was noted that all surfaces of the turbine were absolutely clean and there was no indication of erosion or pitting on the blades. The stationary nozzles of the fourth stage showed slight erosion on the exit edges. It is estimated that the erosion was not extensive enough to cause any trouble for several years.



Detail of mercury unit tube construction, showing filler piece

The mercury side of the condenser was found to be clean but a negligible amount of scale had formed on the steam surfaces.

During the year's operation the mercury unit turned out 135 million kilowatt-hours, including that produced by the steam from the mercury condenser, at a net coal rate of 0.72 lb. per kilowatt-hour with 14,000-B.t.u. coal. This corresponds to an average net kilowatt-hour on 10,100 B.t.u.

N. Y. Legislature Passes Power and Ventilating Bills

THE CORNAIRE BILL providing for the creation of a power authority to develop the hydro-electric resources of the St. Lawrence River was passed by the New York State Senate on April 7 in the form in which it was passed the previous week by the Assembly. It now goes to the Governor for approval. The amendments proposed by the Senate Finance Committee, including designation of the personnel of the power authority to which Governor Roosevelt voiced strong objections, were defeated in the Senate by a vote of 26 to 23.

On April 8 the Assembly passed and sent to the Governor the Mastick bill amending the education law by requiring plans and specifications for new school buildings to assure "proper ventilation," instead of at least 30 cu.ft. of pure air every minute per pupil as provided for in the original law. The provisions of the old law relating to "foul air" were also struck out.

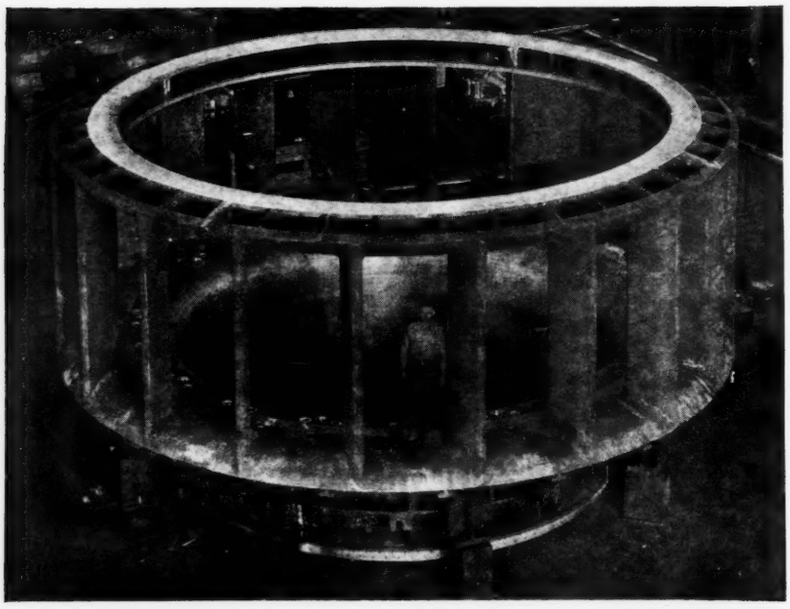
Further developments in legislation at Albany included the introduction in the Senate and Assembly of an act to amend the labor law in relation to the inspection of boilers and unfired pressure vessels. In addition to boiler inspection, the bill proposes inspection once a year of all unfired pressure vessels having a volume of more than 1½ cu.ft. and carrying over 30 lb. per sq.in. pressure, except where a report is filed by a duly authorized insurance company. The fee for such inspection will be from $2 to $10. Exempt from the inspection are those unfired pressure vessels used for the storage and transportation of compressed gases which are manufactured in accordance with the specifications of the United States Interstate Commerce Commission.

South Carolina and Iowa Kill Utility Measures

THE SOUTH CAROLINA HOUSE on April 3 killed the bill proposing to levy an excise tax of three-tenths of a mill per kilowatt-hour on all hydro-electric power generated within the state. The House had previously voted down a similar measure, following which a new bill with a lower tax rate was introduced.

In Iowa, the House rejected on April 3 a bill providing for the creation of a public utilities commission with regulatory power over all classes of utilities.

RUNNER FOR SAFE HARBOR TURBINE



Looking down on the stay and throat rings of the runner for one of three propeller turbines being manufactured by I. P. Morris & De La Vergne, Inc., for the Safe Harbor (Pa.) hydro-electric development. The initial installation of this project consists of six of these units (the other three are being built by the S. Morgan Smith Company), each rated at 42,500 hp. with automatically adjustable blades controlled by the Kaplan System. They will be the largest turbines of this type in America

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Midwest Coal Conference At Univ. of Ill., May 21-22

To IMPROVE and extend the uses of Illinois and Indiana coals, plans are under way for the 1931 Midwest Bituminous Coal Conference to be held at the University of Illinois, Urbana, May 21 and 22. The first of these conferences, held last year on April 9, 10 and 11 at Purdue University, attracted an attendance of over 500 producers, distributors, and users of bituminous coal. For the first time, the conference brought together officially, representatives of the coal, heating equipment, heating and piping, warm-air heating, and power industries as well as leaders in the field of smoke abatement, engineering, education, and general business for the scientific study of the convenient, smokeless, and economical use of the product of midwestern coal mines.

Some 30 subjects centering particularly on utilization and performance of coal in power, industrial, and domestic fields have been suggested for consideration this year and many of the papers are announced on the tentative program just released. Among these are: "Methods of Determining the Relative Value of Coals," by W. D. Langtry; "To What Extent Have Midwest Coals Met Competitive Demands for Better Preparation?" by John A. Garcia and H. C. Cooley; "Comparative Heating Value of Fuels in the Research Residence," by A. C. Willard; "What Does the Future Hold for Midwest Coal?" by S. W. Parr; "Economics and Utilization of Natural Gas in Relation to Midwest Coal"; "Space Requirements for Coal Burning Plants"; "Recommended Setting Heights for Heating Boilers Equipped with Mechanical Stokers," by E. L. Beckwith; "Operating Tests of Stokers in Service"; "Burning Area Requirements as Established by Actual Boiler Tests"; "A Study of Small Stokers for Semi-Industrial and Plant Uses," by G. A. Young and W. T. Miller; "Adapting the Power Plant to Local Coals," by Lisle A. Pierson; "Midwest Coal Combustion Tests," by A. P. Kratz and A. A. Potter; "Training of Plant Operators to Use Illinois and Indiana Coals," by A. W. Cole.

Minor Part License Denied For New River Project

THE FEDERAL POWER COMMISSION on April 3 handed down a decision denying in toto the requests made by the Appalachian Electric Power Company in its application for a minor part license to construct an $11,000,000 power project on New River, near Radford, Va.

The commission denied the power company's motion to reconsider the commission's finding of June 1, 1927, that the interests of interstate or foreign commerce would be affected by the proposed construction; it denied the company's application for a minor part license, and it agreed unanimously that the power company should be tendered a standard form license and ordered that work on the New River dam should not proceed until the company accepts the full license, placing it squarely under control of the commission.

The New River case has aroused nation-wide interest and has been regarded as a test case of the ability of power companies to obtain the much-discussed minor part license, as well as the commission's policy in the issuance of such permits. The decision overrode the company's argument, based on states' rights, although official representatives of five states—Arkansas, West Virginia, Tennessee, Kentucky and Virginia—appeared in support of the argument.

Contract Awarded for Hydraulic Laboratory

AFTER AN ANALYSES of the bids received on the second advertisement for the construction of a hydraulic laboratory building at the Bureau of Standards, the contract was awarded to the firm of Stofflet & Tillotson of Philadelphia on April 7 for an amount of $294,887. The second set of bids were opened on the same day that the award was made. In order to expedite the construction, work will be started ten days after the signing of the contract; time for completion is 330 days.

In response to the readvertisement of the work, seven bids were received. On the first advertisements, sixteen bids were received. The award to Stofflet & Tillotson was not made on its basic bid of $298,987 submitted the second time but was decided upon as the result of deductions made possible by alternate bids. These alternate bids involve the use of ordinary factory sash, omission of top soil and sodding, and the omission of a cooling system for drinking water. Although the W. P. Hose Company was the low bidder on its basic bid of $298,400 its bids on alternates selected by the Bureau of Standards did not bring the amount down as low as the bid of Stofflet & Tillotson.

Other basic bids ranged as follows: George E. Wyne, of Washington, $300,000; Arthur L. Smith Company, Washington, $307,000; Maitico Construction Co., Washington, $307,489; Loudoun & Rust, Washington, $309,705; and the Turner Construction Company of Buffalo, $324,600.

Bush Terminal Adopts Oil-Electric Locomotives

WITH THE PLACING of an order for seven 55-ton oil-electric locomotives with the Ingersoll-Rand Company, the Bush Terminal Company inaugurates the use of this type of motive power in switching service at its terminal in Brooklyn, N. Y. Each of these locomotives will be powered by an Ingersoll-Rand 300-hp. railroad-type diesel engine. The General Electric Company will supply all the electrical equipment.

Seattle Considers Buying Puget Sound System in City

SEATTLE CITY COUNCIL now has before it a proposal to place before the voters at the next March election, the question of taking over the entire distribution System of the Puget Sound Power & Light Company within Seattle's borders, and two of its hydro-electric plants in King and Pierce Counties. The proposal is sponsored by councilmen Frank J. Lanbe, George W. Hill and John E. Carroll, who state that it has been decided to bring the condemnation question to a public issue now, in order that the people may be fully informed on all angles of the subject in time to vote on the proposal next year.

Estimates of the cost of such a purchase have been placed between $50,000,000 and $70,000,000. The purchase is urged by the councilmen named as a means of cutting out costly duplication of pole lines and underground conduits, as well as the expense of double overhead required in the present competition between the private plants and the city system.

J. F. McLaughlin, new president of the Puget Sound Power & Light Company, states that he had no previous knowledge that the ordinance would be introduced. J. D. Ross, former city light superintendent, said the measure was a surprise to him, but strongly urged its passage. He declared that the city ought to be able to buy the properties for between $9,000,000 and $10,000,000, and declared that coupled with the authority given City Light to do its own engineering, the acquirement should save the city $3,000,000 a year. Production costs of power would be lowered materially, he declared, with the elimination of duplication costs.

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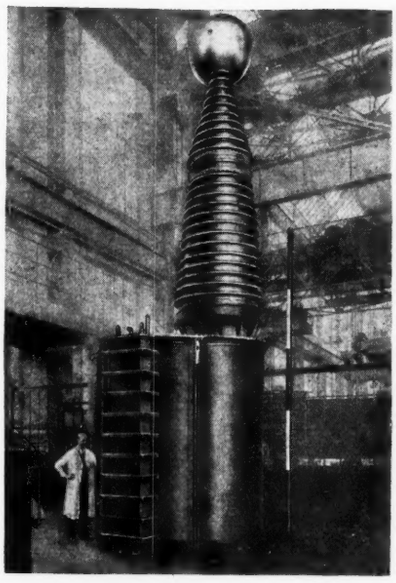
GERMAN TESTING TRANSFORMER



One of two 1,000,000-volt transformers installed in the new 2,000,000-volt testing laboratory of the A.E.G. Berlin. These transformers are insulated for 1,000,000-volts to earth. The voltage is measured by means of a spherical spark gap, the spheres of which are 8 ft. in diameter.

Dr. Baker Reports Plans For Third Coal Conference

IMPORTANT DELEGATIONS of fuel technologists from the principal European countries will attend the Third International Conference on Bituminous Coal at the Carnegie Institute of Technology, Pittsburgh, Pa., on Nov. 16 to 21, according to Dr. Thomas S. Baker, president of the Institute of Technology and organizer of the congresses. Conferences with scientists in the coal centers of Europe during a two months' visit assured Dr. Baker of the interest and co-operation of fuel technologists on the continent.

The program of the third meeting, embracing the more important topics in fuel technology now being considered throughout the world, is progressing rapidly. Since Dr. Baker's return from Europe he has devoted his time to arranging the American program as well as to corresponding with scientists in Europe. In America great progress has been made in reseach since the last conference in 1928, and the program this year will contain announcements of significant developments made in research laboratories in the United States. Special efforts are being made by the committee in charge to arrange inspection visits to the important research laboratories and industrial plans in Pittsburgh and other parts of the country.

Fuel technologists who wish to contribute papers to the conference are urged to apply to the secretary as soon as possible as the program is rapidly being compiled.

New Standard for Heat Symbols Adopted by A.S.A.

A NEW TENTATIVE STANDARD covering symbols for heat and thermodynamics has just been approved by the American Standards Association. The standard is the result of extensive work by the subcommittee for heat and thermodynamics of the Sectional Committee on Scientific and Engineering Symbols and Abbreviations. This committee co-operated with the International Electrotechnical Commission and with the National Research Council in preparing the standard.

The new standard will be of interest to power plant designers, turbine engine designers, boiler designers, and all others working with the problems involving the transfer and transmission of heat. It may be purchased for 30 cents per copy from the American Standards Association, 29 West 39th St., New York City.

C. W. Naylor, Chief Engineer Of Marshall Field, Dies

CHARLES WILLIAM NAYLOR, chief engineer of Marshall Field & Company, Chicago, Ill., and past national president of the National Association of Power Engineers, died of heart disease on March 8 at his home in Chicago. He had been on the engineering staff of Marshall Field's department store for the past 45 years and was one of the most popular engineers in the city.

Charles W. Naylor

Mr. Naylor was born in Leeds, England, on Oct. 29, 1858, and was brought to this country by his parents at the age of one year. He early served a mechanics apprenticeship with the Crane Company, after which he graduated from the University of Chicago in 1881. A few years later he entered the employ of the Hay & Prentice Company, then the largest firm of steam-heating and ventilating engineers in Chicago. In 1886 he became first assistant engineer of Field & Leiter, now Marshall Field & Company, and soon rose to the position of chief engineer, which he held at the time of his death.

Joining the N.A.P.E. in 1890, he was elected national president in 1893 and national secretary from 1897 to 1899. He was also a member of the American Society of Mechanical Engineers and the Western Society of Engineers.

Contract Let for Last Link In Texas-Chicago Gas Line

CONTRACT for construction of the last section of the world's longest natural gas pipe line which extends more than 950 miles from the Texas Panhandle to Chicago has just been awarded to Ford, Bacon & Davis, Inc., engineers. The last or seventh link of this project, running from Rock Island to Joliet, Ill., will be 155 miles long and the contract provides for its completion on or before July 1.

The seventh section will be made of 24-in. pipe, the standard size employed throughout the line, and will cross the

Fox River and the Illinois-Mississippi Drainage Canal. At Joliet the line will connect with the Chicago Belt Distribution System which serves greater Chicago and adjoining territory.

When completed the Texas-Chicago line will serve natural gas to about 50 cities and towns along its route. Estimated reserves of the line are 7,000,000,000,000 cu.ft. These reserves are the property of the nine large utility and oil companies which formulated the plans of the project and organized the Continental Construction Company to carry it out. The companies are Cities Service Company, Standard Oil Company of New Jersey, Insull & Son, Inc., Texas Corporation, Columbian Carbon, Skelly Oil Company, Phillips Petroleum Company, Southwestern Development Company and United Carbon.

Obituary

GEORGE H. ANGELL, superintendent of construction on the 510,000-hp. hydroelectric development at Safe Harbor, Pa., fell dead of heart disease on April 6. During his extensive career, Mr. Angell supervised construction of some of the largest dams in the country. On the Kensico Dam at White Plains, N. Y., he made a concrete-pour record that has never been equalled—his men poured 190,000 cu.yd. in one month. He was in charge of construction of the Ontario Power Company's project at Niagara Falls and built the huge power dam on the Mississippi River in Iowa. He completed in record time the Conowingo Dam and also erected Holtwood Dam. On his job for the Arundel Corporation at Safe Harbor, he was six months ahead of schedule, having poured already 270,000 of the 450,000 cu.yd. of concrete required for the project.

CHARLES B. WATERS, president of the Waters Arc Welding Company of New York, died unexpectedly of heart disease on April 3 at his home in Montclair, N. J. He was 44 years old. Born in New York, Mr. Waters graduated from Columbia University as an electrical engineer in 1908. One of his first important projects was the completion of a power plant for the General Electric Company at Schaghticoke, N. Y. He was later associated with several railroad companies in various capacities. During the war he was active in electrical and construction work in government plants. He completed many successful inventions, one of the most important of which was an electric arc welding device.

W. S. ROBERTSON, who became associated with Combustion Engineering Corporation in 1912, died suddenly of heart failure on March 31 at his home in Newark, N. J. Mr. Robertson was in his 70th year and was actively engaged in sales work as special sales representative for northern New Jersey and eastern Pennsylvania until the time of his death.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-annual meeting in Birmingham, Ala., Apr. 20-23. Meeting at Hartford, Conn., June 1-3. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 15-16. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual convention at Skytop Lodge, Skytop, Pa. May 25-27. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. District meeting in Rochester, N. Y., Apr. 29-May 2. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Spring meeting at the Athletic Club, Kansas City, Mo., May 6-8. Secretary, David L. Fiske, 37 West 39th St., New York.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting in New York City, Apr. 22-24. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 25-26. Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual meeting and exposition at the Cleveland Public Auditorium, Cleveland, Ohio, June 15-19. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

1931 Midwest Bituminous Coal Conference. To be held at the University of Illinois, Urbana, Ill., May 21-22. Chairman of Program Committee, B. R. Gebhart, Illinois Coal Bureau, 307 North Michigan Ave., Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

National Association of Heating and Piping Contractors. Annual convention in Louisville, Ky., May 6-9. Chairman of convention committee, M. J. Chagnard, 419 West Jefferson St., Louisville, Ky.

National District Heating Association. Annual convention at the Hotel Statler, Boston, Mass., June 2-5. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 8-12. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

JOHN R. FREEMAN, widely known hydraulic engineer, will be tendered a testimonial dinner in recognition of his services to the engineering profession, on April 21 at the Providence Biltmore Hotel in Providence, R. I. JAMES A. HALL, professor of mechanical engineering at Brown University, is arranging the program, and HENRY D. SHARPE, treasurer of Brown & Sharpe Manufacturing Company, will preside at the dinner.

PHILIP TORCHIO, vice-president in charge of electrical engineering of the New York Edison Company, has been elected senior vice-president of the company. Mr. Torchio has been connected with the company since 1895. He was chief electrical engineer from 1905 to 1924, when he was made a vice-president. He holds many patents in the United States and foreign countries, covering improvements in electrical apparatus and transmission devices.

B. M. JONES, formerly general engineer of the Duquesne Light Company, has been promoted to the position of planning engineer to succeed E. A. HESTER, who recently assumed wider responsibilities. Mr. Jones has been with the Dusquesne company since 1923, first as relay protection engineer and later as general engineer. Prior to that he was a general engineer with the Westinghouse Electric & Manufacturing Company.

GEORGE G. LANDIS has recently been made chief engineer of the Lincoln Electric Company. Starting with the company eight years ago, Mr. Landis was placed in charge of experimental activities. Later he assumed supervision of the electrical and mechanical design of both motors and arc welders. He is responsible for many of the patents held by the company.

H. T. BURGNER has been appointed chief electrical engineer of the North American Light & Power Company. He was formerly operating electrical engineer of the company.

E. A. OLSEN, vice-president of the Pacific Public Service Company and its subsidiaries, has announced his resignation from this Standard Oil Company affiliate to take over the executive management of the Oklahoma Natural Gas Company with headquarters in Tulsa. Mr. Olsen has had a wide experience in public utility operations both in the South and West.

F. J. GANNON, for the past year president of the El Paso Electric Company, El Paso, Texas, has been transferred to Tampa, Fla., to assume active management of the Tampa Electric Company. The Tampa company is under the executive management of the Stone & Webster Service Corporation, with which Mr. Gannon has been associated for 29 years.

Business Notes

GIFFORD-WOOD COMPANY, Hudson, N. Y., announces its absorption of the C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y. The Gifford-Wood Company will manufacture and sell the complete line of materials handling equipment formerly produced by the Hunt Company and will operate the latter as a division of Gifford-Wood, it is stated.

ALCO PRODUCTS, INC., New York City, announces the opening of branch offices in the Esperson Building, Houston, Texas, and the Philtower Building, Tulsa, Okla. R. H. Brinton will represent the company at Houston and T. B. Leech at Tulsa, as sales engineers.

NORTHERN EQUIPMENT COMPANY, Erie, Pa., announces the appointment of two new sales representatives: The Economy Equipment Company, 301 Buder Building, St. Louis, Mo., and Joseph W. Eshelman, 1220 Webb-Crawford Building, Birmingham, Ala.

FLEXITALLIC GASKET COMPANY, Camden, N. J., announces the appointment of E. H. Bolton, 549 West Randolph St., Chicago, Ill., as its representative in that territory.

AMERICAN PROPELLER COMPANY is moving its entire plant to 401 Bendix Drive, South Bend, Ind., where increased facilities will allow it to engage more extensively in the ventilating field.

WICKES BOILER COMPANY, Saginaw, Mich., announces the appointment of the Kilner-Mills Company, 3-266 General Motors Building, Detroit, Mich., as district representative of its heating division.

GENERAL REFRACTORIES COMPANY, Philadelphia, Pa., has recently appointed the Davis Coal & Supply Company, Reading, Pa., as its distributor in Schuylkill, Berks, Lebanon counties and the northern part of Lancaster County.

PELTON WATER WHEEL COMPANY, San Francisco, Calif., announces the appointment of W. H. Holcomb as general sales manager in charge of sales and distribution of all company products. Mr. Holcomb was formerly manager of the company's pump department.

BARBER-GREENE COMPANY, Aurora, Ill., announces several changes in sales personnel, as follows: E. H. Cooper, since 1927 manager of the Kansas City office, has been made ditcher-line head for the Western division; the territory formerly handled by Mr. Cooper has been divided between the Kenney Machinery Company, 2301 Grand Ave., Kansas City, Mo., and the Buda Engine Service, 521 West Archer St., Tulsa, Okla.; Frank Ness has been appointed manager of the Barber-Greene Philadelphia office; and D. H. McLean has been made manager of the Cleveland office of the company.

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WITH THE SOCIETY SECTIONS

A.S.M.E., Anthracite-Lehigh Valley Section. Meeting and exhibition at the Hotel Altamont, Hazelton, Pa., on Saturday afternoon and evening, April 18. General subject: "Practical Industrial Lubrication." A large number of manufacturers are expected to exhibit small lubricating devices and equipment. Manager, C. W. Bell, 177 East Broad St., Hazleton, Pa.

A.S.M.E., Baltimore Section. Joint meeting with the Baltimore Sections of the A.I.E.E. and A.S.C.E. and the Baltimore Engineers Club at the Pennsylvania Water & Power Company, Holtwood, Pa., on April 23. Subjects: "Holtwood Hydraulic Laboratory and Its Contribution to the Design of the Safe Harbor Development," by G. W. Spaulding, Pennsylvania Water & Power Company; "Construction of the Safe Harbor Development," by C. W. Black, The Arundel Corporation.

A.S.M.E., Metropolitan Section. Meeting in the Engineering Societies Building on April 29 at 8 p.m. Subject: "Developments of the Stationary Diesel Engine Under the Conditions of American Power Economics," by Julius Kuttner, editor of *Diesel Power*.

A.S.M.E., New Haven Section. Meeting at Mason Laboratory, Yale University, on April 24 at 8 p.m. Subject: "Internal Combustion Engines," by Professor L. C. Lichty, Yale University.

A.S.R.E., Boston Section. Dinner meeting at the Chamber of Commerce on April 23 at 6:30 p.m. Subject: "Symposium on Low-Temperature Insulants," by representatives of various low-temperature insulation companies.

National Conference Board on Sanitation. Meeting at the Hotel Biltmore, New York City, on April 16 at 2 p.m. Subject: "The Menace of Smoke," by Elliot H. Whitlock, H. B. Meller, Thomas Darlington, and Shirley W. Wynne.

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Trade Catalogs

STOKER AND STEAM PLANT—A description of a new self-contained underfeed stoker with electric drive and integral fan construction, suitable for firing boilers up to 1,500 sq.ft., is contained in recent folder of the Combustion Engineering Corporation, 200 Madison Ave., New York City. This company has also issued an illustrated bulletin describing the Kips Bay station of the New York Steam Corporation, with particular reference to the fifth steam unit which was recently placed in operation.

REGULATORS—A new 12-page illustrated bulletin covering three types of damper regulators—No. 501 for low-pressure and vapor heating boilers, No. 502 for medium-pressure power boilers, and No. 503 for high-pressure boilers—has recently been issued by the Atlas Valve Company, 282-286 South St., Newark, N. J.

MOTORS AND ELECTRICAL DEVICES—General Electric Company, Schenectady, N. Y., has recently published the following new bulletins: GEA-1352 on Type KG squirrel-cage induction motors; GEA-1368 on vertical, hollow-shaft induction motors for deep-well pumping: GEA-1275 on fractional-horsepower motors; GEA-1262A on thrustors to produce straight-line motion from a motor drive; GEA-1333 on a transformer oil drier and filter; GEA-927B on portable recording instruments; GEA-1354 on carrier-current telephone equipment.

PIPE THREADING—A new catalog covering a complete line of pipe-threading tools and machines has recently been issued by the Oster Manufacturing Company, Cleveland, Ohio. Among the new products described are die stocks, reamers, a small portable pipe machine, and a large gasoline-engine driven pipe machine.

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Fuel Prices

FUEL OIL

Boston—April 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.9c. per gal.

New York—April 9, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—April 8, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl

Pittsburgh—April 1, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c.@3.5c. per gal.; 36@40 deg., 3.125c.@3.5c.

Cincinnati—April 7, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—April 1, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 50c. per bbl.; 22@24 deg., 55c. per bbl.; 24@26 deg., 60c. per bbl.; 26@28 deg., 70c. per bbl.; 28@30 deg., 80c. per bbl.

St. Louis—April 1, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.295 per bbl., or 42 gal.; 26@28 deg., $1.395 per bbl.; 28@30 deg., $1.495 per bbl.; 30@32 deg., $1.595 per bbl.; 32@36 deg., gas oil, 3.276c. per gal.; 38@40 deg., distillate, 4.026c. per gal.

Dallas—April 4, f.o.b. local refinery 24@26 deg., $1.05 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, h. gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.50 @ 2.00
Smokeless, slack	Chicago	1.25 @ 1.35
Harlan, Ky., slack	Chicago	.70 @ 1.00
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.65 @ 1.75
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	.90 @ 1.25
W. Ky., slack	Louisville	.75 @ .90
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.00
Smokeless, slack	Cincinnati	1.00 @ 1.25
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.75 @ 1.00

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.25
Barley	New York	1.85

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Redwood City — Union Ice Co., 354 Pine St., San Francisco, plans the construction of a 100 x 126 ft. ice manufacturing plant on Brewster Ave. here.

Calif., San Francisco — State Bd. of Harbor Commissioners, awarded contract for addition to cold storage terminal at Pier No. 46 to C. D. DeVelbiss, 369 Pine St.

Calif., West Anaheim—Anaheim Co-operative Orange Association, awarded contract for the construction of a cold storage and pre-cooling plant including refrigeration equipment, etc. on Lincoln Ave. to H. A. Hamm, 2145 Sacramento St., Anaheim. Estimated cost $65,000.

Colo., Ordway—Southern Colorado Power Co., c/o W. N. Clark, Mgr., Pueblo, starting work on enlargement of power sub-station here, also rebuilding transmission line between Rocky Ford and Ordway. Estimated total cost $35,000.

Conn., Newtown — Fairfield State Hospital, N. G. Osborn, New Haven, is having plans prepared for the construction of a group of buildings for new insane asylum at Mill Hill. Estimated cost $1,250,000. W. F. Crabtree, 410 Asylum St., Hartford, is architect.

Ill., Chicago—Cook County Commissioners, County Bldg., is having plans prepared for the construction of a 17 story nurses' home at Lincoln and Polk Sts. Estimated cost $2,350,000. E. E. Hall, 123 West Madison St., is architect.

Ill., Elsah—Principia College, c/o T. E. Blackwell Jr., Bus Mgr., 5457 Page Blvd., St. Louis, Mo., awarded contract for the construction of a group of college buildings to Dickie Construction Co., 317 North 11th St., St. Louis. Estimated cost $3,500,000. Steam heating system, etc. will be installed.

Ind., Fort Wayne—Indiana School for Feeble Minded, is having plans prepared for new power plant and improvements, also new tunnels at Black Hawk Farm, Hicksville Rd. Estimated cost $195,000. R. W. Noland, 408 Cal-Wayne Bldg., is engineer.

Kan., Kansas City—Bd. of Public Utilities, C. A. Lowder, Secy., awarded contract for furnishing and installing equipment for electric wiring for power plant to Kelso-Wagner Electric Co., 134 West 2nd St., Dayton, O. $45,950.

Mass., Boston—Boston Elevated Railway, 31 St. James St., awarded contract for turbo generator for electric plant, Lincoln power station to Westinghouse Electric & Mfg. Co., 150 Broadway, New York. Estimated cost $500,000.

Mich., Detroit—Dept. of Water Supply, G. H. Fenkell, 735 Randolph St., Gen. Mgr., awarded contract for the construction of a power plant to include part of boiler plant, switch house, turbine house, etc., for Springwells water system, West Warren Ave., to W. E. Wood Co., Union Guaranty Bldg. $983,320. Also awarded contract for electric power service system for screen chamber, water supply system to Miller-York Inc., 1523 East Congress St.

Mich., Ypsilanti—Ypsilanti State Hospital, G. R. Thompson, Budget Dir., will soon award contract for waterworks system including three pump homes, etc. Estimated cost $20,000. E. D. Rich, Dir. Dept. of Health, Lansing.

Mo., Kansas City — Missouri-Kansas, Texas R.R., Railway Exchange Bldg., St. Louis, awarded contract for the construction of a grain elevator, 1,000,000 bu. capacity to include head house, conveyor system, etc. to James Stewart Corp., 343 South Dearborn St., Chicago, Ill. Estimated cost $250,000.

N. H., Littleton—Littleton Hospital, H. M. Eaton, Pres., will soon award contract for the construction of a hospital and power house, Rich, Mattesius & Koyl, 320 5th Ave., New York, are architects. C. F. Neergard, 512 5th Ave., New York, N. Y., is engineer.

N. H., Exeter—Phillips Exeter Academy, L. Perry, awarded contract for the construction of a 1 story, 80 x 92 ft. central heating plant to J. Gascoigne & Co., 6 Beacon St., Boston, Mass. Estimated cost $25,000.

N. J., Elizabeth—Bd. of Chosen Freeholders, Court House, will receive bids about May 15 for the construction of a 15 story addition to court house including steam heating and ventilation systems, boilers, elevators, etc. at North Broad and Rahway Sts. Estimated cost $500,000. Oakley & Sons, 1259 Clinton Pl., are architects. P. West, 13 Central Ave., Newark, is engineer.

N. J., Kearny—Public Service Gas & Electric Co., subsidiary of Public Service Corp. of New Jersey, Terminal Bldg., Newark, will soon award contract for equipment for 75,000 kw. electric power generating unit here. Estimated cost to exceed $1,000,000. United Engineers & Constructors, 112 North Broad St., Philadelphia, Pa., in charge of construction.

N. Y., New York — Consolidated Gas Co., Irving Pl., acquired a site and plans the construction of a central distribution gas plant. Maturity indefinite.

N. Y., New York—New York Central R.R., 466 Lexington Ave., will receive bids about April 10 for the construction of a cold storage warehouse including refrigeration plant on 14th St. Estimated cost $700,000. J. M. Doorly, Engr., New York Terminal Dist.

O., Cleveland—W. Alleman, Pittsburgh, Pa., is having plans prepared for the construction of an 18 story hotel on Deering Ave. here. Estimated cost $1,560,000. J. A. Tuck, 613 Union Trust Bldg., Cleveland, is architect.

Pa., Pittsburgh—Duquesne Warehouse Co., A. J. County, Pres., subsidiary of Pennsylvania R.R., Broad St. Station, Philadelphia, plans the construction of a 10 story warehouse including dry and cold storage facilities at 10th and Penn Sts. here.

S. D., Vermillion—City plans the construction of an electric light plant including Diesel electric equipment. Estimated cost $52,000.

Tex., Crystal City—Shippers Cooperative Ice Co., J. L. Price, Pres., plans the construction of a 150 ton ice plant with 5,000 ton storage vault. Estimated cost $150,000. Private plans.

Tex., Laredo—W. H. Anderson, Travis Bldg., San Antonio, G. M. Trout, Laredo and W. Epstein, 310 Craig St., San Antonio, will soon receive bids for the construction of a 10 story office building including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. here. Estimated cost $500,000. Matthews & Kenan, Smith-Young Tower, San Antonio, are consulting engineers. L. D. Royer, Smith-Young Tower, San Antonio, is mechanical engineer.

Tex., Longview—Morgan Utilities Co. Inc., has work under way on the construction of a 100 ton ice plant. Estimated cost $150,000. Private plans. Most of work will be done by day labor.

Tex., Rio Grande City—J. Marriott, National Bank of Commerce Bldg., San Antonio, Archt., will receive bids about April 24 for the construction of a 75 ton ice plant including machinery and equipment here for Central Power & Light Co., National Bank of Commerce Bldg., San Antonio. $90,000. Owner also plans a power and lighting plant at Eagle Pass.

Tex., Yoakum — City acquired a site and plans the construction of a municipal light and water plant. Estimated cost $500,000. Work will be done by local labor.

Va., Quantico—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of boiler plant at Marine Barracks here to M. H. Pagenhardt Co., Washington, D. C. $108,540.

Wash., Seattle—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the construction of a marine hospital at Beacon Hill here. Estimated cost $2,000,000. Bebb & Gould, Hoge Bldg. and John Graham, Dexter-Horton Bldg., are architects.

Man., Winnipeg—Winnipeg Heating Co. Ltd., Rockwood and Dorchester Sts., plans extension to heating plant for supplying heat to structures within certain radius of plant. Estimated cost $1,000,000.

Ont., Guelph—Dept. of Public Works, Parliament Bldgs., Toronto, plans additions and improvements to Ontario Agricultural college including electric sub-station, power house, etc. here. Estimated $260,000. Private plans.

Ont., Hamilton — Hydro-Electric System of Hamilton, is having plans prepared for the construction of a sub-station including equipment. Estimated cost $150,000. E. I. Sifton, 12 King St. E., is engineer. W. J. Walsh, Terminal Bldg., is architect.

Ont., London—Victoria Hospital Trust, W. M. Gartshore, Chn., is having plans prepared for the construction of a new hospital. Estimated cost $1,000,000. Watt & Blackwell, Victor Bldg., Dundas St., are architects.

Ont., Toronto—Canadian National Railways, New Union Station, and Canadian Pacific Railway Co., Windsor St. Station, Montreal, Que., plans the construction of a joint fruit and vegetable terminal building including refrigeration system, heating, etc. on ft. of Bathurst St. Estimated cost $2,000,000.

Ont., Toronto—Canadian Property Holdings, Ltd., c/o N. A. Armstrong Co., Ltd., 7 King St. E., archts., are having plans prepared for a 20 story office building including steam heating and ventilation systems, elevators, etc., at 8-10 King St. W. Estimated cost $1,000,000.

Ont., Toronto—Imperial Bank of Canada, 32 Wellington St. E., plans the construction of an office building including steam heating and ventilation systems, elevators, etc., at King and Bay Sts. Estimated cost $2,000,000. Sproatt & Rolph, 1162 Bay St., are architects.

Hawaii, Oahu — Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans development of naval ammunition depot to consist of 131 buildings, electrical, telephone and water supply systems, etc. here.

Equipment Wanted

Air Compressor—Milwaukee, Wis.—Treasury Dept. Office of the Supervising Architect, Washington, D. C., will receive bids until April 22 for air compressors at U. S. Post Office here.

Engine — Boston, Mass. — P. O. Box 5273, plans to purchase a 150 hp. modern type steam engine.

Pump—Albert Lea, Minn.—City plans to purchase a pump with motor for proposed waterworks improvements. Estimated cost $35,000.

Pump—Cleveland Heights, O.—City, H. H. Canfield, Mgr., is receiving bids for a 1,000 gal. pump.

Pumping Unit—Brownsville, Tex.—Cameron County Water Improvement Dist. 14, c/o L. P. Stovar, will receive bids until April 21 for a new pumping unit in connection with proposed irrigation project.

Pumps—Audubon, Ia.—City plans to purchase four 150 hp. pumps, etc. for proposed waterworks system. Estimated cost $40,000.

Pumps—Jackson, Mich.—City plans to purchase deep well turbine pumps for six wells at Belden Rd. station in connection with waterworks improvements. Estimated cost $147,000.

Industrial Projects

Md., Baltimore—E. Katzinger Co., 1959 North Cicero Ave., Chicago, Ill., awarded contract for the construction of a factory for the manufacture of bakers tinware here to Consolidated Engineering Co., 20 East Franklin St., Baltimore. Estimated cost $60,000.

Mass., Cambridge (Boston P. O.)—Riverside Boiler Works Inc., 50 Harvard St., awarded contract for addition and alterations to factory to F. Leroy Fox Inc., 101 Milk St., Boston. Estimated cost $40,000.

N. J., Jersey City—Montgomery Cylinder & Grinding Co., 678 Montgomery St., had plans prepared for the construction of a 1 story auto engine remodeling plant at Tonnelle Ave. and Allen St. Estimated cost $40,000. O. L. Wutzdorff, 147 Summit Ave., Union City, is architect.

N. J., Newark — Art Metal Works, L. V. Aaronson, Pres., Mulberry St., awarded contract for alterations and additions to buildings No. 1 and 13 at 9-29 Mulberry St. to Henry M. Doremus & Co., 79 Orange St. Estimated cost $40,000.

N. J., Newark—Unique Art Mfg. Co., 196 Waverly Ave., is having plans prepared for the construction of a 2 story factory. Estimated cost $100,000. S. Saul & Co., 24 Commerce St., are architects.

O., Barnesville—Lotus Glass Co., will soon receive bids for a 1 story, 30 x 60 ft. unit of factory to provide added facilities for decorating and silver departments. Estimated cost $40,000.

O., Cleveland—J. C. Virden Co., 6103 Longfellow Ave., manufacturers of electrical goods awarded contract for a 2 story, 35 x 152 ft. addition to factory for the George A. Rutherford Co., 2725 Prospect Ave. Estimated cost $40,000. Equipment including lacquer ovens, spray baths, tumbling barrels, etc. will be required.

O., Warren—United States Gypsum Co., 300 West Adams St., Chicago, Ill., plans the construction of a 1 story factory for the manufacture patented metal arch on Phoenix Rd. here. Estimated cost $100,000.

Ore., Empire—P. H. Boslaph and C. Peter, Newhouse Bldg., Salt Lake City, Utah, announce the organization of a new $2,000,000 corporation for the carbonization and briquetting of coal, 1,500 ton daily capacity here.

Pa., Ridgway—Elk Tanning Co., 2 Park Ave., New York, awarded contract for two additions to tannery, 50 x 160 and 74 x 100 ft. here to Hyde-Murphy Construction Co., Ridgway. Estimated cost to exceed $40,000.

Man., Winnipeg — Christie-Brown Biscuit Co. Ltd., 192-202 King St., East Toronto, Ont., awarded contract for the construction of a 135 x 525 ft. factory including refrigeration and ventilation plant, air-washing plant, biscuit-making machinery and equipment to Hazelton & Walin Ltd. Estimated cost $1,000,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

THE tendency to decline persists in prices of power-plant supplies. Belting, metals, wiping materials, and refractories are lower than a month ago. Advances which occurred in air hose, conduit, elbows and couplings were offset by declines in fire hose and BX cable, No. 14 solid. Prices of electrical supplies, for the most part, were steady during March. Despite present diverse trends in prices of water and air hose, steam hose discounts continue unaffected. Pipe and boiler-covering market remains fairly firm.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft	$0.51
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less	70%

Air—Best Grade, Net

¾-in., per ft	3-ply	$0.271	4 ply $0.337

Steam—Discounts from List

First grade.. 50–10% Second grade.. 50–10–5% Third grade.. 60–10–5%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade....60–10–10% Second grade....70–10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—Cut lacing, best quality, 30-10%; 2nd quality, 50%. Lace leather sides, best, 12-17 sq.ft., 55c. per sq.ft.; 2nd, 48c., net. Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in	$0.90
Asbestos for high-pressure steam, ⅛ in	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.10 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl. in cloth.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $2.50 per 100 lb. in lots of 8,000 to 14,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	7.00@13.00	16.00	13.00
Colored	5.50@9.00	12.00	9.00

WIPING CLOTHS—Prices per pound in lots of about six bales (600 lb.), for colored wipers, as follows:

Chicago	$0.09
New York	.10
Cleveland	.....

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.098	$0.107	$0.106

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list less 60–10% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, full kegs, per 100 lb.:

New York	$4.25
Chicago	4.00
Pittsburgh mill	2.75

Broken kegs, about $1.50 higher.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	32@35

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	44.75
Commercial genuine, intermediate grade	33.75
Anti-friction metal, general service	29.00
No. 4 babbitt, f. o. b.	10.00

COLD-FINISHED STEEL—Warehouse prices on shafting and screw stock, per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.40	$3.35
Flat or square	3.90	3.90	3.85

BOILER FITTINGS—Discounts from list at warehouse:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list, are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	30%	13%

LAP WELD

2	57%	45½%	2	23%	7%
2½ to 6	61%	49½%	2½ to 3	26%	11%
7 and 8	58%	45½%	3½ to 6	28%	13%
9 and 10	56%	43½%	7 and 8	26%	11%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1¼	62%	51½%	1 to 1¼	30%	14%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	23%	19%
2½ to 4	59%	48½%	2½ to 4	29%	15%
4½ to 6	58%	47½%	4½ to 6	28%	14%
7 and 8	54%	41½%	7 and 8	21%	7%
9 and 10	47%	34½%	9 to 12	16%	2%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..$0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3¼ to 4 in..... .10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$21.00	$34.00	$66.00	$86.75
No. 12 solid....	38.02	50.52	76.00	104.00
No. 10 solid....	52.10	66.22	95.00	124.00
No. 8 stranded..	85.34	105.22	133.00	185.00
No. 6 stranded..	123.58	148.81	180.00	253.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Couplings	GALVANIZED Elbows	BLACK Conduit	BLACK Couplings	BLACK Elbows
¼	$59.07	$3.40	$8.14	$53.85	$3.09	$6.97
⅜	59.67	4.08	8.19	54.45	3.71	7.02
½	60.85	4.77	8.31	55.63	4.34	7.14
¾	77.55	6.84	10.94	70.47	6.23	9.41
1	111.17	8.93	16.34	100.71	8.13	14.06
1¼	150.41	12.59	22.45	136.26	11.54	19.69
1½	179.86	15.59	30.03	162.94	14.29	26.33
2	242.01	20.86	54.65	219.24	19.14	47.88
2½	382.64	29.80	90.41	346.64	27.33	79.33
3	500.40	44.66	233.65	453.32	40.97	204.12
3½	630.26	59.90	511.67	573.66	54.98	446.44
4	769.04	74.67	591.65	701.96	68.51	516.27
4½	895.85	111.37	891.90	817.71	102.13	777.77
5	1044.28	122.88	1240.38	953.21	112.72	1081.94
6	1354.64	177.68	1547.21	1236.49	162.91	1350.30

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$15.00
No. 16 cotton reinforced heavy		19.00
No. 18 cotton reinforced light		12.00
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		13.00
No. 16 cotton Canvasite cord		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.50
0–30 ampere, less than standard package, per 100	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.06

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.90	$6.80	$7.60	$13.45
12	7.10	8.40	9.60	17.30
10	8.75	10.75	12.60	23.00
8	13.70	15.75	18.10	33.00
6	.....	.....	24.25	.....
4	.....	.....	36.00	.....
2	.....	.....	49.50	.....
1	.....	.....	55.00	.....
0	.....	.....	87.00	.....
00	.....	.....	101 00	.....
000	.....	.....	122.00	.....
0000	.....	.....	150.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In or Pendant Cap Key	Keyless	Pull	¾ In. Cap Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 27c. per lb.
Wire solder, in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	50%
Less than standard package	45%